

SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH 1907.

GENERAL PHYSICS.

367. *Poisson's Ratio for Caoutchouc.* L. Schiller. (Ann. d. Physik, 22. 1. pp. 204-208, Dec. 28, 1906.)—The thickness of the material used in the experiments described was 1.07 mm., the length of the strips about 250 mm., and the breadth (measured between two marks on the surface) about 10 mm. If b_0, l_0, b, l denote the breadths and lengths before and after stretching, then μ (Poisson's ratio) = $\log(b_0/b) \div \log(l_0/l)$. The mean of 20 results gives $\mu = 0.480$, whereas Frank [Ibid. 21. 8. p. 602, Nov. 20, 1906] obtained 0.460. This difference is discussed, the author attributing it to a possible difference of material and to the different ratio of length to breadth of the specimens used. Using a square piece of rubber, the author found $\mu = 0.467$. A. W.

368. *The Brinell Hardness Test.* H. le Chatelier. (Soc. d'Encouragement. Rev. de Métallurgie, Mém. 8. pp. 527-538, Dec., 1906. Review of papers presented at the Brussels Congress of the Internat. Assoc. for Testing Materials, 1906.)—Benedicks has shown that the hardness number H that would be obtained with a 10-mm. ball and 8,000 kg. pressure can be found from the formula $H = H_1 dp \sqrt{(d/10)20000/(17000 + p)}$, when a hardness number H_1 is found with a ball of diam. d and a pressure p . Brinell's original figure, 0.846, for the ratio between max. tensile stress and hardness number, has been closely verified by more recent work. Dillner's experiments also give a mean of 0.846, and he calculates 0.848 as a mean from some of Charpy's results. Ast gives 0.856, and Breuil 0.864, the latter figure being obtained by a much less refined method of measuring the diam. of impressions. Most of these workers used a wide variety of steels. Ast gives hardness measurements across sections of ingots which show the greater softness of the outer portion as compared with the interior. The author argues that one may expect with ordinary precautions to work to within 3 per cent. error with this method. In addition to Guillery's method [see Abstract No. 22258 (1904)], Brinell proposes an impact hardness-testing arrangement, in which a weight is allowed to fall on the ball-holder; the apparatus is simple and portable, consisting of a steel pipe guiding the weight, a catch to hold and release it, and the ball-holder fitted in the lower end. The weight and fall are proportioned so as to give about the same diam. of impression on a 0.1 per cent.

carbon steel as is given by 8,000 kg. static pressure, and are 5 kg. and 0.45 m., the ball being of 10 mm. diam. in either case. J. Roos compares the impact with the static method, and shows that A^2/Q is constant, where A is the area of the surface of the impression and Q the energy in the falling weight. Tests do not accurately bear this out, but useful approximate values of the ratio H_i/H_s (H_i = hardness number, impact; H_s = hardness number, static) are, for steels containing up to 0.2 per cent. C, 110; 0.8 to 0.6; 117; 0.7 to 1.2, 135. The author discusses the substitution of a standardised Brinell test for ordinary tensile test, as weight of evidence appears to point to practically invariable agreement between hardness number and max. tensile stress. When elongation is required tensile specimens may be broken without measurement of load, in a relatively inexpensive machine. These tests would be well supplemented by a standardised notched impact test.

F. R.

369. *Art of Cutting Metals.* F. W. Taylor. (Amer. Soc. Mech. Engin., Proc. 28. pp. 1-248, Mid-Nov., 1906. President's Address, Dec., 1906. Discussion, pp. 929-941, Jan., 1907. Mech. Eng. 18. pp. 922-925, Dec. 29, 1906; 19. pp. 26-32, Jan. 5; 59-61, Jan. 12; 83-86, Jan. 19; 112-115, Jan. 26; 144-147, Feb. 2; 182-186, Feb. 9; 262-266, Feb. 23; 304-308, March 2; 332-336, March 9; 369-374, March 16 *et seq.*, 1907.)—In the course of the paper, which describes at length the evolution of the Taylor-White original high-speed steels, and the more recent work of those investigators, it is stated that their microscopic study of high-speed steels, though incomplete, showed no structural criterion for high-speed working—i.e., steels of a variety of structures gave satisfactory results as tools. The author's method of treatment has produced first-class tools from all good brands of American, English, and German high-speed steels on the market—at least as good as those produced by following the maker's directions in each case. Their treatment briefly is: Heat slowly to 815° C., then rapidly to just below the melting-point; cool quickly to below 845°, and afterwards either quickly or slowly; heat to 620° for 5 min., and cool either quickly or slowly. The best high-speed steel at which the author and White have as yet arrived has the following percentage composition: C, 0.68; W, 18; Cr, 5.7; V, 0.3; Mn, 0.09; Si, 0.046. The photomicrographs given are quoted from Carpenter's work dealt with in Abstract No. 518 (1907). No satisfactory explanation of the development of "red-hardness" by the heat-treatment at 620° has as yet been adduced.

F. R.

370. *Measurement of Resistance of Metals to Rapid Deformation.* P. Vieille and R. Liouville. (Comptes Rendus, 143. pp. 1218-1221, Dec. 31, 1906.)—The authors' comparisons of the effect of static compression and of firing, in the usual way, on copper crushers, show that with increased speed of crushing the difference between the deformation under static and dynamic loading increases rapidly with the deformation when greater than 1 mm., and has a mean value of about 8 per cent. of the deformation within the ordinary range of ballistic work—e.g., with deformations of about 2.65 mm., corresponding to 1,700 kg., the difference between static and dynamic deformations was 0.88 mm. for a speed of 1.44 m., 0.86 mm. for 0.51 m., and 0.85 for 0.17 m. Two crushers were used in series, with an intermediate light piston; in the first place the similarity of deformation in the two crushers proved the negligibility of inertia of the pistons. The method of initially statically compressing the rear copper was adopted—the effect of this strain

is found to be practically only to shift the origin of strain—the initial difference between the two coppers, if slight, being maintained. Hence it is possible to study the comparative effects of static and dynamic loading in this way, without autographically recording strain. [See also Abstract No. 1174 (1906).] F. R.

371. Experimental Study of Riveting. C. Frémont. (Mém. Soc. d'Encouragement, pp. 1-145, 1906.)—The author's experiments are described in detail, with curves and photographs. The more smoothly the holes are reamed, the better will the rivets fill the holes; for iron rivets, the holes should be countersunk at both ends. Long rivets fill the holes better if in making the rivet a collar of metal be left under the head. Failure upon contraction is traced to absence of countersink; to avoid this class of failure countersinks should be long in direction of length of hole. Mild steels of from 22 to 28 tons per sq. in. tensile strength are shown to possess in the highest degree the properties necessary for boiler and bridge rivets. The effect of punching holes in plates is not essentially to make the metal about them dangerously brittle. This brittleness, as well as that of rivet metal, is inherent in the sample, or arises from overheating in the case of the rivet—not from riveting at too high temperature. The shock test [see Abstract No. 695 (1905)] is recommended for detecting such brittleness in a consignment of rivet steel; the specimen should absorb 20 kg.-m. in breaking. Steels of this class require from 75 to 100 tons per sq. in., and wrought iron 56 tons per sq. in. to close the rivet hot—these loads are reckoned upon the area of body of rivet, and ordinary working temperatures assumed for each metal. The maximum pressure should be maintained upon the rivet for at least 80 sec. The edge of the die should be very narrow—not over 1.2 mm.—in order to minimise frictional resistance to the outward flow of excess metal. Experiments show that the ordinary proportions of rivet heads leave a margin of strength in the head, even if the rivet be put in direct tension. A preliminary study of the energy required to close rivets under various conditions, using power, or by hand, includes a determination by means of cinematograph and chronograph of the course and velocity of the hammer when hand power is used. In some cases hand riveting required as much as 550 per cent. of the energy required in hydraulic riveting. The evolution of mechanical riveters is outlined and illustrated. [See also Abstracts Nos. 1678 and 1847 (1905).] F. R.

372. The Hardening of Metals by Overstrain. H. Hort. (Zeitschr. Vereines Deutsch. Ing. 50, pp. 2110-2113, Dec. 29, 1906.)—In the author's tensile tests both the following stress-strain curves were observed: (a) the upper curve for a uniform ordinary rate of stretching, and (b) the lower curve for practically infinitely slow stretching. By ceasing to load at any point on (a) the curve falls to a point on (b) in time; a mechanical explanation of this is offered depending on the difference between static and sliding friction. The form of the irregularities obtained thus or through every-day non-uniformity of stretching are not characteristic of the material, so much as they are dependent on the elasticity of the parts of the testing machine. [See also Abstract No. 9 (1907).] F. R.

373. Resistance of Iron and Steel to Reversals of Stress. T. E. Stanton and L. Bairstow. (Inst. Civ. Engin., Proc. 166, pp. 78-110; Discussion and Correspondence, pp. 111-184, 1905-1906. Communicated from the

National Physical Laboratory.)—Direct stresses were applied in a machine similar in general principle to that of Reynolds and Smith. So far as comparisons can be made, it is concluded that the resistance of metals to fatigue at 800 cycles of stress per min. is no less than that found by previous workers at 60 cycles per min. The max. range of stress to which a sample can be subjected a large number of times without fracture is independent, within fairly wide limits, of the actual numerical value of the max. stress. The max. range is of course only obtainable with a specimen whose section does not alter rapidly; for other forms the range bears a definite ratio to the max. range, depending on the rapidity of change of section. The table gives the max. range of stress in tons per sq. in. and the limiting ranges for several rates of change of section, the ratio of tension to compression being 1·4, and the number of reversals safely withstood, 1,000,000 :—

	Max. Range.	Specimen Screw-cut, V thread.	Specimen having Moderately Rapid Change of Section.	Specimen having Sudden Change of Section.
Swedish Bessemer steel, No. 8...	31·5	21·9	21·6	15·8
„ „ „ „ No. 2...	30·4	21·8	21·8	14·4
„ „ „ „ No. 1...	26·8	18·0	18·3	18·0
„ charcoal iron.....	19·0	18·0	12·3	10·8
Piston-rod steel.....	28·3	18·6	20·0	16·9
Steel forging	20·6	—	—	—
Mild steel, No. 2	25·8	18·4	18·5	14·1
„ „ „ „ No. 1	18·9	18·8	18·6	12·2
Wrought iron, No. 2	19·2	—	—	—
„ „ „ „ No. 1	21·6	16·7	17·5	12·9

The microscopic study of the nature of the actions taking place during the fatiguing shows them to be similar to those observed by previous investigators in the case of materials submitted to transverse stresses. In particular the tendency for surfaces of weakness to pass through the ferrite of medium carbon steels is confirmed. In the *discussion*, **W. C. Unwin** gave results of fatigue tests of mild steel at 400° to 500° F., in which the specimens were found to be slightly more enduring than when at atmospheric temperature. **A. B. W. Kennedy** gave a curve showing the max. range of stress with a given max. tension in a given material. *Correspondence*.—**F. Osmond** considered that ultimate fracture under repeated stress was not the result of the development of slip-bands, but arose either from cubic cleavages, or Neumann's lamellæ. **F. R.**

374. Motion of Liquids through Large Tubes. **H. Merczyng.** (*Comptes Rendus*, 144, pp. 70-72, Jan. 14, 1907.)—In this paper the author describes experiments on the flow of water, sometimes carrying sand in suspension, through horizontal conduits 200 m. long and of diameters 0·5 m. and 0·88 m. respectively. The results obtained for the hydraulic pressure-fall are much higher than those given by Darcy's extrapolation formula. It is probable that the law connecting velocity and pressure-fall is not given by Darcy's binomial expression, but by a complicated exponential one; the results, however, confirm the theory of Darcy and Levy that the pressure-fall increases with diminution of the diam. of the tube. With sand in suspen-

sion it is shown that the loss of head, for the same velocity, is greater than for pure water, and the loss is greater the greater the proportion of sand carried.

A. W.

375. Relation between Breaking Stress and Extension in Tensile Tests of Steel. **A. Mallock.** (Roy. Soc., Proc. Ser. A. 78. pp. 472-478, Feb. 2, 1907.)—The author has observed that the sum of tensile strength (as ordinarily reckoned) and percentage elongation of good ordinary steels which are not in a state of mechanical strain initially, approximates to 67 or 68—a number which, he states, is not altered by heat treatments. Assuming that the "intrinsic strength" (final load divided by contracted area) is constant for such materials, and is about 70 tons per sq. in., and assuming a negative exponential law for the variation of diameter along the broken piece, it is shown that the above-named sum should be nearly constant. This is shown graphically, and a table of test results is added supporting the views in the paper.

F. R.

376. Elimination of Velocity Effects in measuring Pressures in a Fluid Stream. **F. E. Nipher.** (Amer. Phil. Soc., Philadelphia, Proc. 45. pp. 77-81, Jan.-April, 1906.)—The author points out the difficulty of obtaining accurate results for either pressures or velocities with search tubes. In the case of the Pitot tube even, having a similar tube with an opening at right angles to the stream lines in a pipe, the results are misleading if the velocity be great. A series of experiments has been made by the author with the object of eliminating the static pressure. The Pitot tube, 1 in. diam. and with thin metal walls, was mounted on a moving car in such a way that the mouth of the tube could be directed, outside the window, at any angle, which was read on a graduated circle. The zero angle was that when the mouth was directed towards the front of the train, at which point the pressure was a maximum, readings being every 10° for a complete 360° . For angles between 0° and 60° the pressures are found to be positive, being zero at 60° . At 90° the decrease in pressure is greater than the increase in pressure for angle 0° . The values are tabulated and plotted in a polar diagram, and were obtained by a water manometer with inclined tube. The average velocity of the train as determined by simultaneous measurements with another Pitot was 41.8 m.p.h., the relative velocity of the air with respect to the train being 82.5 m.p.h. From these results it is evident that the mouth of the tube which is to eliminate velocity effects should be set at an angle of 60° with the stream lines, and not be at 90° as is usual. Hence to separate velocity pressure from static pressures, two tubes rigidly connected and having their axes at an angle of 60° inserted into the pipe through which air is flowing, may be used. One tube is so turned in the stream that the reading of its gauge is a maximum; this will indicate both pressures. The other indicates only the actual pressure due to resistance of the pipe in advance of that point, if the discharge is into the air. Another means of eliminating velocity effects is described and illustrated. This consists of a tube to carry the pressure to the gauge, which terminates at a point where the pressure is to be measured, in a thin circular disc placed edgewise in the stream. A parallel disc is fixed to it by rivets, with four or five circular sheets of wire gauze loosely clamped between the discs. The gauze should project some distance beyond the discs. These disc collectors may also be used with good results in water-pipes if the velocity is not great enough to produce discontinuities.

L. H. W.

377. The Diffusion through Palladium of Electrolytically-evolved Hydrogen. **A. Lessing.** (Deutsch. Phys. Gesell., Verh. 8, 22, pp. 569-575, Nov. 30, 1906, Phys. Inst. d. techn. Hochschule, Charlottenburg.)—Nernst and Lessing showed in 1902 that for the diffusion of hydrogen through palladium the effective potential is that of the hydrogen-charged palladium plate. By methods similar to those of Nernst and Lessing the present author has studied the subject more exactly and come to the following conclusion: As in the case of all diffusion phenomena, so in the case of the diffusion through metals of electrolytically-evolved gases, the velocity of diffusion is proportional to the difference of concentration at each point; the potential measurement serves solely for the determination of the gas concentration in the metals studied. **D. H. J.**

378. Theory of Synoptical Air-pressure Variations. **F. M. Exner.** (Akad. Wiss. Wien, Sitz. Ber. 115, 2a, pp. 1171-1246, July, 1906. Zentralanstalt f. Meteorologie, Wien, June, 1906.)—Air-pressure, wind, and temperature change too rapidly for the interval of 12 or 24 hours of our synoptic charts. When in Washington in 1904, the author therefore copied the records of the Weather Bureau for every fourth hour of January, 1895; these barograph, thermograph, and anemograph records, obtained at 44 stations of the U.S., he afterwards supplemented at Toronto by the records from 4 Canadian stations, making 48 stations in all, 6 of which are situated at levels above 1,000 m., the highest station being Santa Fé, 2,138 m. In the course of his analysis he comes to the conclusion that 2-hour records would have been better still. The daily influence of solar heat having been eliminated so far as possible, the author starts from the barometric formula $p = p_1 e^{gH/RT}$, where p is the air pressure at the surface, p_1 the pressure at the height H , T the mean temperature of this air column H . The height H at which p_1 becomes constant is deduced from the data under the supposition that the mean temperature curve T follows the surface temperature curve. This supposition is found to hold for the central district, less well for the Pacific coast. The author concludes that the variation in the air pressure at the surface is inversely proportional to the area bordered by two neighbouring isobars and two H lines, this area being determined by superposing the isobar and the H charts. Four examples of integration under different assumptions of the final differential equation are given in the second part of the paper in order to ascertain whether these considerations, which disregard rain and friction at the earth's surface, are in accordance with the usual observations. The general drift of atmospheric disturbances towards the east is accounted for. As the continent is cold and the sea warm in winter, the linear fall of pressure towards the north produces a periodically recurring low-pressure sack (depression), which crosses the American continent in about five days. The lowest pressure in the sack is observed in the central portion of the continent where H has its minimum. **H. B.**

379. Meteorological Kites in Samoa. **F. Linke.** (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 5, pp. 493-508, 1906.)—The Samoa Observatory was built in 1902 by Tetens, on behalf of the Kgl. Gesell. Wiss. Göttingen, on the peninsula of Mulinnu close to Apia. Kite-flying was started by the author after the cessation of the rainy season, in May, 1906; the results of twelve ascents, some made with six kites on a wire up to 4,800 m. in length, are tabulated and discussed; heights of 2,850 m. were attained. One of the kites was found afterwards bearing two days' records of the meteorological condi-

tions in the virgin forest. All the ascents were made in the dry season, May to Aug., 1906, and on trade-wind days. The temperature decreases rapidly at first, to a height varying between 800 and 2,200 m.; the relative humidity in this stratum rises up to 90 per cent., the wind is SE. or ESE. Then follows an inversion layer, 100 or 200 m. in thickness, in which the temperature may rise by 8° ; afterwards a warm, dry current from E. or ENE., with a relative humidity of 8 per cent.; the cirrus drift on the same days was from N. and NNW. The general conditions agree with Hergesell's observations on the trade winds of the northern hemisphere. H. B.

380. Velocity of Sea-waves through the Pacific. K. Honda. (Physico-Mathematical Soc., Tokyo, Proc. 8. 9. pp. 185-189, Nov., 1906.)—The velocities of earthquake waves crossing the Pacific between America and Japan have been calculated by Milne, Geinitz, and others; they assumed different paths for the waves, and the results did not agree. The author renews these calculations, which he applies also to the Columbia and Valparaiso earthquakes of 1906, conceiving different paths to different stations in Japan and elsewhere. The distances of these earthquakes ranged from 6,000 to 17,600 km., the time-intervals from 7.6 to 25 hours, the mean depths of the sea from 6 to 5.8 (Columbia earthquake) and 5.5 and 5.29 km. (Valparaiso earthquake), the resulting velocities from 185 to 217 m./sec. The following are a few of the values for $\sqrt{gh}$ (h = depth) and the resulting velocity: South American wave of 1868, 243, velocity 185; Columbia, 289 and 294, velocity from 195 to 218; Valparaiso, 282 and 228, velocity 200 to 217 m./sec. Thus the hydrodynamical value of the velocity is always higher than the value deduced from these observations. The waves from more distant points seem to travel slightly faster than those from smaller distances; the observations made at Misaki are exceptional in this respect. These sea-waves give rise to oscillations in six Japanese bays, of the same periods as those produced by ordinary waves, the periods being different for the different bays, in accordance with the views of Terada, Yoshida, and the Author. H. B.

381. Calculation of the Period of Seiches. D. Isitani. (Physico-Mathematical Soc., Tokyo, Proc. 8. 9. pp. 170-178, Nov., 1906.)—The period of vibration of a liquid in a vessel of varying section may approximately be calculated on the assumption that the mode of oscillation is approximately the same in the simple and the derived system. On this assumption the author deduces mathematically, without applications, an expression representing the change of period due to a slight alteration in the area and volume of the oscillating liquid. The effect of a change of section and breadth would be greatest near a node or near a loop. Thus a correction would have to be made in the calculation of seiches and allied phenomena relating to the secondary vibrations observed in bays and estuaries. H. B.

382. Notes on Seiches, Calculation of their Periods and Nodes. T. Terada. (Physico-Mathematical Soc., Tokyo, Proc. 8. 9. pp. 174-181, Nov., 1906.)—Chrystal [see Abstract No. 1698 (1905)], having in his theory of seiches compared the oscillations of an irregularly-shaped lake with the vibrations of a string, the author utilises the analogy of an organ-pipe and deduces two formulæ, the second of which also considers the velocity component at right angles to the length of the canal. These formulæ are roughly confirmed by

experiments conducted with a tank, 87 cm. in length and 16 cm. in breadth, whose depth and breadth could be varied with the aid of bent brass plates. The second formula applied to the periods of the uninodal and binodal oscillations of Lake Hakone, which has been investigated by Nakamura and Yoshida, gives a good agreement between observed and calculated values. The seiches of dumb-bell shaped lakes require a different treatment. The formula arrived at is confirmed by experiments with two circular basins joined by a canal of uniform rectangular section, the maximum length of this canal being 28.5 cm.; the agreement is less satisfactory when the depth of the canal is comparatively great, viz., 7.2 cm. H. B.

383. *Propagation of Earthquake-waves within the Earth.* H. Benndorf. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 941-982, June, 1906.)—In continuation of former work [see Abstract No. 847 (1906)] the importance of determining the angle of emergence of an earthquake shock is pointed out; for the ratio of the actual speed c of the waves just before emergence to the apparent speed along the earth's surface is the cosine of this angle. This is true both for the longitudinal and the transverse waves. Measurements by this method give 5.5 km. per sec. as the average value of c at emergence, and from certain considerations it is calculated that c increases sharply to 10.8 at a depth of $\frac{1}{2}R$ (where R is the earth's radius), then very gradually to 11.8 at depth $\frac{1}{3}R$, then more quickly to 15.7 at depth $\frac{1}{4}R$, finally remaining at about this value to the earth's centre. A method of determining the depth of the disturbance is also indicated. R. E. B.

384. *Calabrian Earthquake, Sept. 8, 1905.* G. Mercalli. (Comptes Rendus, 144. pp. 110-112, Jan. 14, 1907.)—The earthquake was preceded by the following phenomena: (a) Two small shocks between Sept. 8 and 8; (b) a recrudescence of activity of the volcano Stromboli and a sensible shock in Western Calabria on Aug. 29; (c) a strong emission of sulphuretted hydrogen from the thermal waters at Sambiasi; (d) a slight trembling about an hour before the great shock. According to its intensity this earthquake ranks among the twenty greatest since 1600, but for extent of area devastated it equals the two former greatest, in 1688 (March 27) and 1783 (Feb. 5). Details are given of the attendant phenomena and analysis of simultaneous observations at various places for the determination of the epicentre and other features. C. P. B.

385. *Solar Corona and disturbed Solar Areas.* A. L. Cortie. (Astrophys. Journ. 24. pp. 855-860, Dec., 1906.)—It is well established that there exists a general connection between the state of disturbance of the sun's surface and the solar corona, but there is still some doubt whether the sun-spots or prominences are the more intimately connected with the coronal phenomena. In the Stonyhurst photographs of the corona taken on Aug. 30, 1906, at Vinaroz, Spain, the streamers seem in general to mark the regions of the prominences rather than of the sun-spots. The general tendency of all the more marked streamers is poleward, while the fine group of prominences in the north-east quadrant is evidently associated with three fine streamers. The author concludes there is highly probable evidence that not only in general is a characteristic type of solar corona associated with sun-spot and prominence activity, but that definite structures in the corona are associated with definite areas of activity of sun-spots and faculae. C. P. B.

386. *Apparatus for Registering the Solar Atmosphere.* H. Deslandres. (Comptes Rendus, 143, pp. 1210-1216, Dec. 31, 1906.)—The recent tendency to secure regular registration of solar variations by means of international co-operation has largely increased the requirements as regards instrumental efficiency. The necessary instruments fall into three groups, designed for recording (1) general chemical compositions, (2) forms of vapours, (3) their radial motions, respectively. The author deals here mainly with the second group, or spectroheliographs, which he classifies systematically under five main types of construction, depending on the method of securing the relative motion of the first slit and the solar image. In type (1) the sun's diurnal motion is utilised alone, and in type (2) in combination with the driving clock. In type (3) the astronomical objective alone is displaced, a method not yet applied. In type (4) the first and second slits are displaced simultaneously, the instrument being fixed. In the Meudon type (5) the spectrograph as a whole is displaced simultaneously with the photographic plate, this method being adapted for large images and direct magnification. The spectroheliographs at present in use are designed for the bright lines H and K, which do not need high dispersion, and the cameras do not exceed 1 m. or 1.5 m. But if it is desired to separate the dark lines throughout the spectrum, much higher dispersion and greater dimensions will be necessary. The author proposes two different designs for a spectroheliograph of type (3), for use with an astronomical objective of 60 cm. and focal length 15 m., the first having a grating 5 cm. in height, the second two 8-cm. prisms and two 60-cm. concave mirrors. A diminishing system furnished with a slit and a prism (for eliminating diffuse light) is added, so that the instrument may be described as a three-slit spectroheliograph. A design is also given for a polychromatic spectroheliograph of low dispersion, intended for observing clouds of solid particles. It is symmetrical about the second slit, and revolves as a whole about the optic axis of the astronomical objective, which remains fixed. Yet a fourth plan unites the advantages of the preceding, being highly dispersive and also polychromatic. It isolates the whole light of one broad line, or a small portion of this line, or several lines at once, as desired. It has two 60-cm. concave mirrors and two 30° half-prisms, silvered on one side and 16 cm. wide. Spectro-registrars for recording, over the entire disc, the radial velocities of H and K, and the thicknesses of the three calcium layers must also have large dimensions, and, as the motion is discontinuous, it is recommended in this case also to leave the instrument at rest, displacing only the astronomical objective and the plate. Finally, spectro-registrars for recording general chemical composition and radial motion of vapours close to sun-spots have high dispersion and special movements. The spectrograph and astronomical objective are fixed, the first slit and the plate are displaced, but in the direction parallel to the spectrum lines, and not perpendicular to them, as before. The photographed spectrum is as extended as possible, and, in order to recognise to what portion of the spot it corresponds, the image of the spot on the collimator slit is photographed beside it on the same plate. The registration of radial velocities has so far only been effected at Meudon. A.E.

387. *Aurora and Sun-spot Frequencies.* C. Chree. (Phil. Mag. 18, pp. 149-164, Jan., 1907. Paper read before the Physical Soc., Nov. 28, 1906.)—In a former communication [Abstract No. 184 (1906)] the author employed Wolf's formula for discussing variations of mean diurnal inequality of magnetic declination, and showed that it could also be applied to magnetic

inclination, horizontal force, and vertical force. These are discussed for seasonal variation, as it is known that in temperate latitudes, whether sun-spots be many or few, the diurnal range of any magnetic element is larger in summer than in winter. In these latitudes, also, magnetic storms are usually associated with brilliant auroræ, and, as previous analyses have not shown any striking correspondence, it was decided to examine the frequencies of auroræ from the standpoint of the above law. The sun-spot frequencies are taken from Wolfer's tables, giving the data for each individual month for the 158 years from 1749-1901. The auroral frequencies are from Tromholt's and Lovering's observations. Analysis of the resulting tables shows that in the 88-year period characterised by few sun-spots summer occurrences of auroræ were relatively much fewer and winter occurrences more numerous than in the adjacent 88-year periods of high average sun-spot frequency. Thus there is found in the case of auroral displays exactly the same type of variation which is exhibited by the elements of terrestrial magnetism. It is emphasised, however, that many of the records of auroræ are so heterogeneous that some caution is necessary in their discussion, and it may be that the frequency of auroræ depends to no small extent on something more than the contemporaneous value of sun-spot frequency. C. P. B.

388. *Helium Line in Fraunhofer Spectrum.* A. A. Buss. (Observatory, 30. pp. 62-64, Jan., 1907. *Nature*, 75. p. 281, Jan. 17, 1907. Abstract.)—The author states that he has frequently seen the helium line D_3 in the yellow, as a dark line in the Fraunhofer spectrum, over areas of faculæ where there was no apparent evidence of spot activity. He has never seen the line in the *umbra* of spots, and suggests that it might be seen oftener as an extremely fine line in the ordinary spectrum if special search were made for it with instruments of large dispersion. C. P. B.

389. *Silicon in the Chromosphere.* A. Fowler. (Roy. Astronom. Soc., Monthly Notices, 67. p. 157, Dec., 1906. *Nature*, 75. p. 304, Jan. 24, 1907. Abstract.)—The presence of silicon was identified by the observations of two of its strong lines, $\lambda 6847.81$ and $\lambda 6871.57$, as well-marked chromospheric lines. Both lines occur in the Fraunhofer spectrum, and Rowland ascribed the latter to iron, while leaving the former unidentified. It is probable that the two lines are enhanced lines. C. P. B.

390. *Formula of Planetary Rotations.* É. Belot. (Comptes Rendus, 143. pp. 1126-1127, Dec. 24, 1906.)—A formula of two terms is given for representing these rotations to a very close approximation. T being expressed in hours, a the distance from the centre of the system, in terms of the earth's orbit; D the planet's diam. (earth = 1); d = density (water = 1); then—

$$T = \frac{28.75}{\sqrt{a D^{\frac{1}{2}}}} + \frac{0.61 D}{\sqrt{d}}$$

The results given by this formula are compared with the observed values, the difference in most cases being remarkably small. C. P. B.

391. *Atmospheres of Mercury and Venus.* P. Salet. (Comptes Rendus, 143. p. 1125, Dec. 24, 1906.)—Referring to Landerer's observation in 1892 of the probable polarisation of the light from Venus, indicating a thick layer of clouds on its surface, the author proceeds to describe his own observations

on the planet Mercury. Employing both Wollaston prisms and Savart polariscopes in conjunction with the East Equatorial of the Paris Observatory, the apparatus was so adjusted that at least three bands would fill the diameter of the planet. In the evening observations a red screen was employed to render the bands sharper, and to diminish the polarised light of the atmosphere which is always rich in violet rays. The bands were placed at 45° to the vertical in order to suppress any possible horizontal polarisations due to refraction. With these precautions he concludes that the light from the planet Mercury is not sensibly polarised, but it would be premature to base on this any conjectures as to the constitution of the planet's atmosphere. It is known that the various parts of the moon's surface present different polarisation phenomena, so it may be that the surface of Mercury is such as to prevent the bands being visible. C. P. B.

392. *Considerations on the Motion of Translation of Stars: Aberration. Stoenescu-Dunare.* (Annal. Scientifiques de l'Univ. de Jassy, 4. pp. 125-189, Jan., 1907.)—The author gives a mathematical proof, by aid of the mechanical theory of light, of Fresnel's intuitive law $v = V(1 - 1/N^2)$ for the velocity v with which the luminous waves are dragged with the earth's atmosphere in its motion, during their passage through it. Here V represents the velocity of translation of the atmosphere, and N the refractive index of air. Since N is very nearly unity, v is very small. The effect of the motion on Fresnel's wave-surface is also considered, by examining the behaviour of the trajectory of a luminous wave in the motion relative to axes of co-ordinates carried with the observer at velocity V . A. E.

393. *Remarkable Nebula in Cetus. M. Wolf.* (Roy. Astronom. Soc., Monthly Notices, 67. p. 91, Nov., 1906. Nature, 75. pp. 281-282, Jan. 17, 1907. Abstract.)—On four plates taken with the Bruce 16-in. telescope during Sept., 1906, the author found an extended nebula near to the star 26 Ceti. It is a remarkable exception to the general rule that most extended nebulosities lie near to the Milky Way, as it is some 70° from the galactic plane. The position of its densest portion is RA = 0h. 57.4m.; Decl. = $+1^\circ 20'$ (1885). It is also remarkable in appearance, as around the dense portion there appear faint masses of nebulous matter of varying intensity. Farther out the intensity is so feeble that it is impossible to exactly define its limits, but it is hoped to improve on this when longer exposures have been given, those up to the present not exceeding 4 hours. With this exposure the nebulous cloud extends about $40'$ in declination and about $80'$ in RA. Three BD stars are involved in the cloud. When examined under the microscope the brighter parts of the mass are seen to be filled with numerous very small spots and short trails, so that the appearance is very different from that of the Milky Way nebulae, and it may consist of a multitude of very small planetary nebulae collected in a cluster, which a more powerful instrument may resolve. C. P. B.

394. *Orbit of Comet 1819 IV (Blanpain), and Possibility of the Capture of this Comet by Jupiter. I. Lagarde.* (Comptes Rendus, 144. pp. 181-188, Jan. 28, 1907.)—Comet 1819 IV. is a short-period one, seen during only one apparition, and observed at Marseilles, Bologna, Milan, and Paris. Encke's elements (Berliner Jahrbuch, 1824), which give the period as 4.8 years, make the orbit lie entirely within the orbit of Jupiter—a circumstance difficult to

reconcile with the theory of capture by that planet. The author finds that Encke's elements need corrections which, when applied, do away with this difficulty. The corrected elements, though probably nearer the truth than Encke's, are still open to considerable uncertainty. Hence the discovery of new documents permitting other observations to be utilised would be of interest. A. E.

REFERENCES.

395. *Shortened Barometer with Renewable Vacuum.* L. Ubbelohde. (Königl. Materialprüfungsamt, Mitt. 24. 6. pp. 309-312, 1906.)—Illustrated.

396. *Calculation of the Compressibility of Gases from the Critical Constants.* D. Berthelot. (Comptes Rendus, 144. pp. 194-197, Jan. 28, 1907.)—Guye's method is bad as introducing empirical constants and using a non-homogeneous formula which cannot be applied to corresponding states though these are assumed. The author states his own method, which has already been given, and which suits the experimental measures; but he prefers the direct to this indirect method of calculation. R. E. B.

397. *Setting of Cement.* M. Gary. (Königl. Materialprüfungsamt, Mitt. 24. 5. pp. 225-235, 1906.)—Gives comparative results on the time of setting as observed by Vicat's needle, and by the temperature method, which show good agreement—rather closer than that between observations made with Vicat's, Tetmajer's, and Goodman's respective forms of apparatus. It is argued that the validity of the temperature peak as an indication of setting is established, and is preferable to any test which tends to disturb the cement; it is also applicable to cement mortar. F. R.

398. *Quasi-waves of Explosion.* P. Duhem. (Comptes Rendus, 144. pp. 179-181, Jan. 28, 1907.)—An error of sign having crept into a former paper [see Abstract No. 1007 (1906)], the results there given require modification and then agree with conclusions already given by Jouguet. R. E. B.

399. *Direction of Local Winds as affected by Contiguous Areas of Land and Water.* T. H. Davis. (Monthly Weather Rev. 34. pp. 410-413, Sept., 1906.)—Studying the wind records for the period 1891 to 1902 from San Francisco and San Diego on the Pacific coast, of Galveston on the Gulf of Mexico, of Savannah, New York, New Haven, Boston, and Eastport on the Atlantic, and of Marquette, Chicago, Cleveland, Toronto on the Great Lakes, the author points out that land and sea winds are more frequent than is generally assumed, especially on the Pacific coast. Their direction may vary in individual months, but their frequencies do not depart much from the average. The influence of the tides is further to be investigated. H. B.

400. *Spanish Eclipse Observations, Aug. 30, 1905.* R. Cirera. (Observatoire de l'Ebre, Mém. 1. pp. 7-56, 1906.)—The memoir gives full details of the preparations, instrumental equipment, and results obtained during the last total solar eclipse of Aug. 30, 1905, for which the observatory was especially well fitted in being situated in the track of total obscuration. The internal contacts were photographically registered for position. Polariscopic and spectroscopic observations were both made, and several excellent photographs of the corona obtained. Other branches of research were also undertaken, including photometry, atmospheric ionisation and potential gradients, meteorological observations, variations of magnetic elements and earth currents. [See Abstract No. 581 (1906).] C. P. B.

LIGHT.

401. Refractive Power of Gases at very Low Temperatures. K. Scheel. (Deutsch. Phys. Gesell., Verh. 9. 1. pp. 24-36, Jan. 15, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—The change of optical length k of a given actual thickness h of a gas when its pressure was altered from 76 to 0 cm. was measured both at 16° and -190° C. by means of a Fizeau's apparatus for determining expansibilities: the ratio k/h gives the change of the refractive index $\mu - 1$. The gases employed were air, hydrogen, and nitrogen, and the light used was 5 helium and 4 mercury bright lines. The density of hydrogen at -190° being estimated from Travers and Senter's data and that of nitrogen from Bestelmeyer and Valentiner's, these gases are found to conform to the law $(\mu - 1)/d = \text{const.}$ with deviations of not more than 0.4 per cent. within the range 16° to -190° . R. E. B.

402. Absorption of Benzene Vapours in the Ultra-violet. L. Grebe. (Zeitschr. Wiss. Phot. 3. pp. 376-394, 1905. Chem. Centralblatt, 1. p. 341, 1906. Abstract.)—A spark discharge between aluminium points immersed in water was employed to produce the rays, which were then passed through a tube containing the vapour to be examined, at the ordinary temperature and at 80° . The vapours investigated comprised benzene, toluene, ethylbenzene, *p*, *m*, and *o*-xylenes, chlorobenzene, bromobenzene, iodobenzene, and aniline. In the case of benzene the lines of the spectrum are regularly arranged, but such regularity is hardly traceable in the cases of the other vapours. The distance from the ortho-position in the isomeric compounds tends to increase the absorption, and to cause displacement towards the red. The absorption bands of the liquids are, however, displaced towards the violet in the spectra of the vapours. L. H. W.

403. Investigation of the Absorption of Light in Solutions. E. Müller. (Ann. d. Physik, 21. 8. pp. 515-534, Nov. 20, 1906. Phys. Inst. d. Univ., Heidelberg, Aug. 13, 1906.)—The author has examined aqueous solutions of inorganic salts (copper sulphate and chloride, nickel sulphate, potassium chromate) by means of the König-Martens spectral photometer. Of two equal beams of homogeneous light (from a helium or hydrogen tube or a mercury lamp) one passed through a tube containing solvent only, the other through a tube containing the solution; by interchanging the tubes all errors were eliminated; the tubes were heated electrically over a range of temperature from $17-70^{\circ}$; the strengths of the solutions were mostly calculated from the densities. The values of the extinction-coefficients increase throughout with increasing temperature, and are always independent of the thickness of the layer of liquid, both for clear and turbid solutions. The author discusses his results from the point of view of the dissociation theory, and, in the case of copper and nickel salts, supports the conclusions which have been drawn as to the colour of the solutions. The dissociation phenomena are, however, complicated by the coincident association and hydration. If the solvent acts neither on the ions nor on the molecule, the molecular coefficient of extinction must be a linear function of the degree of dissociation. It was found, however, that with increasing dilution of cupric chloride solutions, the mole-

cular extinction-coefficients diminish rapidly for short waves, less rapidly for longer waves. The extinction-coefficient of copper sulphate solutions is a linear function of the temperature; the same is true in the case of copper chloride only for those wave-lengths for which the coefficient of extinction is nearly constant. Blue solutions of cupric chloride become green on heating, but the green is not the same as that produced by concentrating, and the author suggests that we have dissociation, association, and hydration in both cases, but in different proportions. D. H. J.

404. *Absorption of some Solids for Light of extremely short Wave-lengths.* T. Lyman. (Astrophys. Journ. 25. pp. 45-52, Jan., 1907.)—The observations recorded in this paper deal with that part of the spectrum discovered by Schumann and lying between $\lambda 2000$ and $\lambda 1250$ Å.U. The grating spectro-scope used by the author in previous work [Abstract No. 1052 (1906)], though well adapted for wave-length measurement, is not convenient for general investigation, and the use of a prism spectro-scope offers greater facility in several respects. The difficulty, however, of obtaining suitable prisms and lenses is considerable; white fluorite is the only substance which has hitherto been used, and even this very expensive material absorbs completely in the neighbourhood of $\lambda 1280$. The purpose of the present research was to discover some substance as transparent as fluorite, and existing in masses of sufficient size to permit the manufacture of prisms and lenses. Even if it only existed in small crystals, such a substance would serve the purpose of a window for a large vacuum spectro-scope. The author has constructed a new vacuum instrument for the research. In it the photographic plate is replaced by a fluorescent screen coated with willemite, and the place of grating is taken by a concave mirror and fluorite prism. The mirror has a radius of curvature 25 cm. and is movable about horizontal and vertical axes. In order to secure brilliant illumination no slit is used, the end of the capillary of a discharge tube serving itself as the source. The bits of the substances examined are fastened over holes in a disc, which can be rotated so that each specimen is brought in turn before the end of the capillary, and at about 6 mm. distance from it. The substances examined were quartz, fluorite, white and coloured, topaz, gypsum, celestite, rock-salt, barite, alum, colemanite, and sugar, all in thickness of 1 to 2 mm. The following were tested also, in the hope of discovering selective absorption, and were found perfectly opaque to light of shorter wave-length than 2000: borax, adularia, calcite, chrysoberyl, sanidin, arragonite, apophyllite, silver chloride, Kunzite, and diamond. As regards its main object, the investigation was unsuccessful; *fluorite* still remains the only known substance transparent to $\lambda 1250$. While colourless fluorite is in general far more transparent than the tinted varieties, yet coloured fluorite does exist of sufficient transparency to serve in apparatus intended for the exploration of the region between $\lambda 2000$ and $\lambda 1250$. Though clear fluorite is rare, the coloured varieties are fairly common, and may be obtained in masses of fair size. Depth of colour is a good indication of absorption, but a notable exception was found in the case of a light-green crystal from Westmoreland, New Hampshire, which was nearly as transparent as Zeiss' specimens. It is well known that coloured fluorite loses its colour on heating, but it does not gain in transparency by the process. Quartz in thickness of 1 to 2 mm. is transparent to $\lambda 1500$ —a useful fact—but the absorption increases rapidly with thickness. Hence, in researches near $\lambda 1600$, quartz may be employed for thin windows, though it is useless for thick prisms or lenses beyond that limit. Direction of optic axis or of rotation makes no difference in the trans-

parency. *Topaz* gives the next best results, particularly Ceylon specimens. *Gypsum* and *celestite*, about 1 mm. thick, show a spectrum as far as $\lambda 1650$ or $\lambda 1700$. *Rock-salt* gives disappointing results; the view held by some authorities that it is as transparent as quartz in the extreme ultra-violet appears to be far from true. *Barite* is about equal to rock-salt, its spectrum ending about $\lambda 1770$. *Alum* 1 mm. thick shows a spectrum ending near $\lambda 1750$, but rather stronger than that of rock-salt. *Colemanite* is transparent to near $\lambda 1750$; *Sugar* less so. None of the substances examined show absorption bands between $\lambda 2000$ and $\lambda 1250$, but the tests were not of great delicacy. The fluorescent substance, willemite, responds to light of extremely short wave-length. A. E.

405. *Ionisation and Absorption and Anomalous Dispersion*. G. A. Schott. (Nature, 76, p. 271, Jan. 17, 1907.)—With the object of further investigating the phenomenon of the emission of line spectra by the positive ions according to J. Stark [see Abstract No. 297 (1906)], the author arranged an experiment in which a current is passing through the sodium vapour which is producing anomalous dispersion according to R. W. Wood. The curves for anomalous dispersion and current show that every variation of ionisation is accompanied by variation of anomalous dispersion. It is therefore suggested that the D lines of sodium are due to positive ions—not to neutral atoms. S. G. S.

406. *Haidinger's Brushes*. O. Lummer. (Ann. d. Physik, 22, 1, pp. 49–68, Dec. 28, 1906. Phys. Inst., Breslau, Oct. 22, 1906.)—The author prefers to call Haidinger's brushes "interference curves of equal inclination." The theory which he has formulated enables us to test plane-parallel plates for equal thickness to within 0.0005 mm. It forms the basis of a powerful method of interference spectroscopy, allowing of a great difference of path, and presenting a severe test for the homogeneity of a source of light. Michelson's echelon spectroscope may be replaced by a single plane-parallel plate. At grazing incidence such a plate, of suitable dimensions, shows interference fringes with steeply decreasing intensity, which yield a high resolving power. In the present work the author investigates the dependence of the sharpness of the curves of equal inclination in polarised light upon the azimuth of the polariser and analyser, and attempts an explanation of the peculiar behaviour of the intensity gradient and the curious doubling of the number of fringes. E. E. F.

407. *Theory of Flicker Photometers*. J. S. Dow. (Electrician, 58, pp. 609–611, Feb. 1, and pp. 647–649, Feb. 8, 1907.)—All flicker photometers now in use, with the possible exception of Wild's grease-spot photometer [see Abstract No. 992a (1906)], seem to be modifications of the original flicker photometers devised by Rood (Amer. Journ. Sci. 8, p. 194, 1899) and Whitman (Phys. Rev. 8, p. 241, 1895–6). The author has obtained very good results with a Rood photometer, but like all instruments in which the principle of the Ritchie wedge is employed there is a possibility of "angle" errors. The advantage of flicker photometers is that unpractised observers can use them. Practised observers probably get more accurate results with a contrast photometer. The author suggests the following method of using the principle of contrast in a flicker photometer. The portions of the photometrical surfaces forming the field of view are of appreciable size, and hence that portion which is nearest to either of the lights being compared is perceptibly

lighter than that which is furthest away. For this reason we can usually see a faint flicker round the edge of the field of view when the centre portion appears flickerless. If the aperture be made larger this effect is distinctly noticeable. In the balancing position the flicker on each side of the field has the same intensity. If the balance be not quite perfect the flicker on one side is greater than that on the other, and hence the balance position can be readily found. The fatiguing effect on the eye of the flicker photometer is mentioned as a drawback, the after-effects sometimes lasting for days. The writer proves that a colour-blind person does not always obtain the same results with a flicker photometer as a person with normal sight. For scientific purposes the only satisfactory method of comparing lights is by a spectrophotometer. It is proved that the flicker method and the equality of brightness method give different results when lights of different colours are compared. Finally, the author discusses the possibility of obtaining stroboscopic effects when lights, the candle-power of which is rapidly fluctuating, are compared. When an alternating arc is compared with a glow-lamp, stroboscopic bands are distinctly visible on the rotating sector disc. **A. P. Trotter.** (*Ibid.* p. 695, Feb. 15, 1907.)—Trotter wishes further information on the following paragraph taken from Dow's paper: "There is one particular speed at which, when the photometer is in balance, the flicker can just be made to disappear completely. For lower speeds the flicker can never be quite made to disappear. For higher speeds the range over which the photometer can be moved out of balance without the flicker reappearing becomes greater and greater." For accurate work, therefore, it appears to be necessary to adjust the speed to the illumination, and, as the object is to discover the equality of two unknown illuminations, successive approximations and adjustments of speed must be made. The question naturally arises whether it is advisable to use a photometer of this type for accurate work.

A. R.

408. Luminous Efficiency of Incandescent Lamps. J. Russner. (*Phys. Zeitschr.* 8, pp. 120-123, Feb. 15, 1907; *Rev. Électrique*, 7, pp. 144-145, March 15, 1907.)—The method of determining the luminous efficiency of an incandescent lamp depending on the use of an absorbing screen of water is unreliable, owing to the fact that water by no means absorbs all the heat rays. The author has found that an excellent absorbing medium for the heat rays is furnished by a solution of the double sulphate $\text{FeSO}_4(\text{NH}_4)_2\text{SO}_4 + 6\text{H}_2\text{O}$, which is commercially obtainable. The solution is at first turbid, but may be cleared by the addition of a few drops of sulphuric acid. It is advisable to filter it before use. Experiments have shown that a thickness of 20 mm. of a 30 per cent. solution of this kind will completely absorb the dark radiation from a glow-lamp. A spectroscopic examination of the light before and after passage through the absorbing screen shows that all the luminous radiation is transmitted. By placing an incandescent lamp suitably modified in a beaker of about 100 mm. diam. and 200 mm. high containing about 1,800 c.cm. of a 30 per cent. solution of the salt mentioned, and measuring the temperature-rise very accurately by a Beckmann's thermometer, the author was able to determine the luminous efficiency of various types of glow-lamps, with the following results:—

Type of Lamp	Carbon	Filament	Tantalum	Osmium	Cerium
Luminous efficiency, per cent. ...	0.61	2.2	2.8	2.46	

A. H.

409. *Stereoscopic Effect and a Suggested Improvement in Binocular Microscopes.* J. Rheinberg. (Quekett Club, Journ. Ser. 2. 9. pp. 871-894, Nov., 1906.)—A disquisition on stereoscopic effect as applied to microscopes. To have pictures of maximum clearness it is desirable to have the diffusion discs, which go to form the whole image except the one plane which is in good focus, as small as possible and circular in shape. Circular stops should, therefore, be used just small enough to secure the necessary depth of focus but no more. These stops may be placed (1) immediately in front of the objective; (2) between the lens and the Wenham or Riddell prism; or (3) above the eyepieces in the plane of the Ramsden circle. Theoretically the last-named is the best place, but it cannot always be recommended owing to the minute size of the Ramsden circle. G. E. A.

410. *Three-colour Printing Process.* [Demonstration by W. A. Sims.] (Photographic Journ. 47. pp. 4-6; Discussion, pp. 6-8, Jan., 1907.)—Three negatives are made through filters, and prints taken by means of the rotary stripping film which is coated on thin transparent celluloid. The celluloid is placed next to the negative in printing. After printing, the film is washed in cold water and developed in hot water at 85° F. All three prints are developed at the same time, and superimposed while in a wet condition. Discussion.—O'Farrell had been unable to work successfully at a lower temperature than 100° to 110°; Mees had obtained fair results by drying the films quickly after sensitising, and then using them within one or two hours. G. E. A.

411. *Emission of Light caused by α -Rays.* J. Stark. (Phys. Zeitschr. 7. pp. 892-898, Dec. 1, 1906. Écl. Électr. 49. pp. 494-496, Dec. 29, 1906.)—The first part of the paper deals with some experiments which prove that an electric field has no action upon the emission of the band spectrum by nitrogen under the influence of the α -rays. The author considers that band spectra are produced by the reunion of negative electrons with the positively charged atomic ions. Since it follows that an electric field would very considerably influence the phenomenon if these ions had perfectly free and unrestrained movements, therefore the theory is put forward that the α -particles when discharged into nitrogen only cause a partial separation of the electron from the positive atomic ion. The reunion of these partially dissociated systems would be unacted upon by an electric field. In the latter portion of the paper the author describes methods for the investigation of the spectra of the luminescence of different gases under the influence of α -rays, and also for investigating whether the α -particles themselves are luminescent—a fact which is considered to be very probable from analogy with the canal rays.

E. C. C. B.

412. *Supposed Line-displacement in Spark Spectra.* C. Keller. (Zeitschr. Wiss. Phot. 4. pp. 209-231, 1906. Chem. Centralblatt, 2. pp. 1231-1232, 1906. Abstract.)—A comparison of the arc and spark spectra of a number of metals shows that although the lines of the arc spectra are displaced by pressure, those of the spark spectra do not suffer displacement under similar conditions. The spectra examined were those of Ti, Fe, Zn, Sn, Al, and Cd. L. H. W.

413. *The Continuous Rays observed in the Spark Spectra of Metalloids and some Metals.* W. N. Hartley. (Roy. Soc., Proc. Ser. A. 78. pp. 403-405, Dec. 20, 1906.)—Some doubt having been thrown upon the author's theory

that the background of continuous rays in the spark spectra of Te, As, Sb, Bi, is caused by an incandescent oxide of the element, he has re-investigated the question by observing the spectra of sparks passing between electrodes of the elements in atmospheres of different gases. Inasmuch as the continuous spectrum is most conspicuous when the spark passes in an atmosphere of hydrogen or nitrogen and weakest in air or CO_2 , it is evident that the explanation, based on the presence of an incandescent oxide, must fail.

E. C. C. B.

414. *Spectroscopic Theory*. H. Crew. (Science, 25, pp. 1-12, Jan. 4, 1907. Vice-presidential address to Amer. Assoc. for Advance. of Science, Dec. 28, 1906.)—The author briefly reviews the early progress of spectroscopy, and selects several of the more important criteria which must be satisfied by any theory which may be put forward for their explanation. The conception of the "atom" which the author thinks fulfils the required conditions most nearly is that put forward by Kelvin, and afterwards modified by Lorentz, Thomson, and Larmor. From its proposed structure it may be termed the *Saturnian atom*. Conceive a single negatively charged electron placed inside a mass of positive electrification. On the basis of the Zeeman-effect we may imagine this electron to be revolving about the centre of the positive charge, and we may assume its rate of revolution to be such that it is in equilibrium under the *first-power-of-the-distance* law. Even if the Zeeman-effect did not suggest rotation, it would still be necessary to introduce it to secure stability, as has been shown by Jeans on the basis of Earnshaw's theory. Then, suppose that there are a large number of such corpuscles distributed along the orbit. If the ring does not contain so many of these self-repellent corpuscles as to become unstable, we have a simple type of a non-luminous, and, during stability, non radio-active element. Imagine now that these electrons are the same for all elements; then one element differs from another mainly in the number, disposition, and character of the rings which surround the central attracting charge, the number of corpuscles being of the same order as the atomic weight. Taking this Saturnian atom as his basis, the author then proceeds to apply it to the criteria he first collected, showing, however, that most of the phenomena are still beyond explanation. C. P. B.

415. *The Zeeman-effect as evidenced by the Blue Lines of Zinc*. P. Weiss and A. Cotton. (Comptes Rendus, 144, pp. 180-181, Jan. 21, 1907.)—The Zeeman-effect in the case of the zinc lines $\lambda = 4810$, $\lambda = 4722$, and $\lambda = 4680$, has been very carefully studied, and the authors find that the distance between the components is undoubtedly proportional to the strength of the field. They attribute Reese and Kent's failure to observe this to the fact that the latter failed to resolve some of the components, and, therefore, were unable accurately to measure their position. They confirm Runge and Paschen's observation that $\Delta\lambda/\lambda^2 H$ is a constant, and find that it has a value of 1.88×10^{-5} , and finally the value of 8.54×10^7 is obtained for the ratio e/m .

E. C. C. B.

416. *Phosphorescent Sulphides*. L. Vanino. (Journ. Prakt. Chemie, 78, 2, pp. 446-448, 1906.)—A radio-active preparation of lead was first laid directly on a black paper envelope containing a photographic plate, and next when enclosed in a celluloid capsule. The blackening of the plate is found to take place to about the same extent in the two cases; celluloid absorbs the

β - and γ -rays only very slightly. With calcium and zinc sulphides, on the other hand, no action is observed when enclosed in celluloid, though blackening takes place when the sulphide is laid on the plate envelope. The sulphides hence do not give off Becquerel rays. The phosphorescence of calcium sulphide decreases when suspended in water, and disappears completely after four months, but suspensions of calcium sulphide in ether, acetone, and ethyl and amyl alcohols retain their phosphorescence practically undiminished.

L. H. W.

417. *Modifications in a Magnetic Field of Absorption Bands of Crystals of Tysonite.* J. Becquerel. (Comptes Rendus, 144, pp. 182-184, Jan. 21, 1907.)—The sense of the displacements of the absorption bands due to the magnetic field corresponds for some bands to electrons, i.e., with the usual negative charge, but for other bands the sense of the displacement corresponds to what are here called *positive* electrons. [See also Abstracts Nos. 886 and 1056 (1906), 286 and 266 (1907).]

E. H. B.

418. *Canal Rays in Compound Gases.* S. Kinoshita. (Phys. Zeitschr. 8, pp. 85-88, Jan. 15, 1907.)—The methods used for investigating the Doppler-effect in the case of hydrogen, nitrogen, and mercury [see Abstracts Nos. 55, 56, and 57 (1907)] are here applied to the case of compound gases. Acetylene, coal gas, nitrous oxide and CO_2 are examined and in all cases it is necessary to keep renewing the gas on account of the dissociating action of the canal rays. As in the previous cases, the bands do not show a trace of the Doppler-effect, but the lines do. The carbon line 4265.7 was particularly studied, and from the value of the velocity as determined by the Doppler-effect it is probable that it is emitted by a monovalent positive carbon ion. From the width of the intensity minima it appears that in the case of acetylene the velocity of this ion will not be great enough to cause an emission that will produce any appreciable photographic effect unless the cathode p.d. considerably exceed 1,210 volts.

S. G. S.

419. *Behaviour of Uranium and Thorium Compounds in the Electric Arc.* F. Wächter. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a, pp. 1247-1260, July, 1906.)—The author thinks that if Rutherford and Soddy's disintegration hypothesis is correct, then subjecting the active compounds to the temperature of the arc ought to increase their activity. Plates of the oxides are placed in the arc and their photographic activity afterwards compared with portions of the unheated compounds. A decrease in activity is found, whereas if the high temperature caused the formation of UxX or ThX an increase might be expected. This may be due to uranium and thorium both being inactive, the active component being distilled by the arc. Further experiments do not support this view and the cause of this behaviour is left an open question.

R. S. W.

420. *Absorption-coefficients of Uranium Compounds.* H. M. Goettsch. (Amer. Chem. Soc., Journ. 28, pp. 1541-1555, Nov., 1906. Contribution from the Kent Chem. Lab. of the Univ. of Chicago.)—The theory of the absorption of radio-activity of uranium compounds, developed by McCoy [see Abstract No. 1222 (1906)], is found to hold exactly for urano-uramic oxide, uranic acid, uranyl iodate, uranyl thiosulphate, sodium uranate, and uranyl ammonium phosphate. The absorption is independent of the form of the measuring

instrument and measurements can be accurately duplicated. The theory that radio-activity is an atomic phenomenon receives additional confirmation in the constant value obtained for k_1/P , where k_1 is the total activity for no absorption of the rays and P is the weight of uranium in 1 gm. of the compound. The absorption is not proportional to the molecular weight, the black oxide of uranium, for example, having a low absorption and a very high molecular weight. It is probable that absorption, like radio-activity, is an atomic phenomenon. T. H. P.

421. *Absorption of the α -Rays of Radium.* H. N. McCoy and H. M. Goettsch. (Amer. Chem. Soc., Journ. 28, pp. 1555-1560, Nov., 1906. Contribution from the Kent Chem. Lab. of the Univ. of Chicago.)—From the study of a number of uranium compounds the authors deduce the following conclusions: (1) Absorption of radio-activity is, like activity itself, an atomic property, independent of the form of chemical combination. (2) The absorption by unit weight per unit area is, for any element, inversely proportional to the square-root of its atomic weight. (3) The radio-activity of a thick film of any pure uranium compound may be calculated from its chemical composition. [See also Abstract No. 1222 (1905).] T. H. P.

422. *Radium and Geology.* J. Joly. (Nature, 75, pp. 294-295, Jan. 24, 1907.)—Arguments are put forward tending to show that radium is not, as is generally assumed, an original constituent of the igneous rocks of the earth's crust. If it were so the presence of associated uranium would have to be assumed to make good the radio-active decay. If such were the case the amount of radium present in sea-water which receives the dissolved rock materials would be much greater than it actually is. Strutt's estimate of the amount of radium in sea-salt is 0.15×10^{-13} gm. per gm. Calculating from the amount of river-water with its dissolved material which enters the ocean, and from Strutt's determination of the mean radium content of the igneous rocks (viz., 5×10^{-13} gm. per c.cm.), in 100×10^6 years there should be 0.19×10^{-10} gm. of radium per gm. of sea-salt. In considering the origin of the radium everywhere distributed over the surface of the earth the author suggests the possibility that it is picked up by the earth in its motion through space, the probable source being the sun. There seems no improbability that matter in minute quantities might reach the earth from the sun; and in the case considered it is minute traces that are in question. W. J. Sollas. (Ibid. p. 319, Jan. 31, 1907.)—Strutt's analysis of granite affords strong support to the view that the radium it contains is of terrestrial origin. It is possible that the richness of granite in radium is due to the removal of this constituent in solution from the general mass of a magma, and its concentration in certain portions which were converted by hydration into granite. There may be other causes, apart from solution, by which electrically charged atoms like those of disintegrating radium have found their way up from below to enrich the outermost layers of the earth. The assumption that radium is equally distributed through a crust 47 miles thick (or possibly 800 miles in thickness) seems to require support from independent evidence. J. J. S.

423. *Radio-activity of the Lava of Vesuvius.* O. Scarpa. (Accad. Lincei, Atti, 16, pp. 44-58, Jan. 6, 1907.)—The author has made several observations of the radio-activity of the eruption products of Vesuvius given out in the eruption of April, 1906, and that of Sept., 1904. The method

of measuring the activity is described, the saturation current being compared with that due to the activity of U_2O_5 under similar conditions. The observations of several other authors are reduced to the same standard, and the general conclusions arrived at are : that the radio-activities of the lavas vary between 1/20000 and 1/1000 of that of uranium and that the products of the older eruptions are slightly more radio-active than those of the recent eruption. [See also Abstract No. 65 (1907).] S. G. S.

REFERENCES.

424. *Photographs with Bas-relief Effects.* G. Michaud. (Scientific American, 96, p. 42, Jan. 12, 1907.)—Bas-relief effects are obtained by printing from a positive transparency superposed on a negative, one plate or film being moved a trifle diagonally so as to slightly destroy the coincidence. [See also Abstract No. 1398 (1906).] G. E. A.

425. *Influence of Light on Photographic Plates.* P. H. Eykman and A. P. H. Trivelli. (Ann. d. Physik, 22. 1. pp. 199-203, Dec. 28, 1906.)—A description of experiments on the effect of Röntgen rays on various photographic plates. A. W.

426. *Fluorescent Screen with Distinct Remanent Image.* Danneberg. (Elektrotechn. Zeitschr. 27. p. 1021, Nov. 1, 1906.)—The author points out the advantages for certain purposes possessed by a screen made with phosphorescent zinc sulphide, especially that produced by the Chininfabrik, of Brunswick, in place of a platino-cyanide screen. Besides being much cheaper and very lasting, the fluorescence persists for some little time after excitation, so that the image can be carefully examined after the rays are stopped. L. H. W.

427. *Refractive Indices of Water and Sea-water.* J. W. Gifford. (Roy. Soc., Proc. Ser. A. 78. pp. 406-409, Dec. 20, 1906.)—The refractive indices of water and sea-water between $\lambda=7950$ and $\lambda=2265$ are given; the values for pure water are given to $\lambda=1938$, beyond which absorption begins. The temperature refraction-coefficients are also given for five different wave-lengths. The author estimates his experimental error in most cases to be no greater than 0.000015, and in no case to be greater than 0.000025. E. C. C. B.

428. *Action of Magnetic Field on the Optical Behaviour of Pleochroic Crystals.* W. Voigt. (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 5. pp. 507-524, 1906.)—A mathematical paper treating on the electron theory the cases recently investigated experimentally by J. Becquerel in which the pleochroic uniaxial crystal xenotime is placed in a magnetic field. [See also Abstracts Nos. 1230 (1906), 236 and 266 (1907).] E. H. B.

429. *Band Spectrum of Boron.* G. Kühne. (Zeitschr. Wiss. Phot. 4. pp. 173-184, 1906. Chem. Centralblatt, 2. p. 1105, 1906. Abstract.)—The author has photographed the spectrum obtained by sparking between carbon electrodes coated with boric acid, using a Rowland concave grating. The wave-lengths are given in tables. L. H. W.

430. *Spectra of Arsenic and of Antimony in a Vacuum Tube.* J. Herpertz. (Zeitschr. Wiss. Phot. 4. pp. 185-197, 1906. Chem. Centralblatt, 2. p. 1105, 1906. Abstract.)—Tables of wave-lengths of the arc and spark spectra of arsenic are given. The antimony spectrum was obtained by heating the trioxide in a hard glass tube. L. H. W.

HEAT.

431. Linear Expansibility of Quartz, Platinum, and Palladium at very Low Temperatures. K. Scheel. (Deutsch. Phys. Gesell., Verh. 9. 1. pp. 8-28, Jan. 15, 1907. Communication from the Physikal.-Techn. Reichsanstalt.)—The apparatus before used [see Abstract No. 640 (1908)] to measure expansibilities by Fizeau's method was modified for use down to the temperature of liquid air and for the removal of the contained air or its replacement by hydrogen, which by its better conductivity did not cause the interference-fringes to become irregular and indistinct, so as to be counted only with uncertainty. Between -190° and 100°C . the observations, expressed by the formula—

$$l/l_0 = 1 + at + bt^2 - ct^3,$$

give for quartz in the direction of its axis $a = 7.085 \times 10^{-6}$, $b = 9.886 \times 10^{-9}$, $c = 7.20 \times 10^{-12}$; for platinum $a = 8.749 \times 10^{-6}$, $b = 8.141 \times 10^{-9}$, $c = 6.94 \times 10^{-12}$ [compare Abstract No. 278 (1907)]; for palladium $a = 1.1521 \times 10^{-5}$, $b = 5.187 \times 10^{-9}$, $c = 1.124 \times 10^{-11}$. For amorphous quartz the observations give $a = 2.17 \times 10^{-5}$, $b = 2.879 \times 10^{-9}$, $c = 0$, so that the length is a minimum at -45.6° ; thus a length of 200,000 at 0° contracts to 199,999 at -46° , but then expands to 200,009 at -190° . The expansibility of two specimens of crystalline quartz was found to vary by 0.42 per cent. [See also Abstracts Nos. 818, 811, 8212 (1904).] R. E. B.

432. Latent Heat of Steam between 80° and 100°C . F. Henning. (Ann. d. Physik, 21. 5. pp. 849-878, Dec. 14, 1906. Communication from the Physikal.-Techn. Reichsanstalt.)—Water was kept continuously boiling at constant temperature by means of an electric heater, the steam generated and the electric energy used in any given time being measured. The temperatures employed were obtained by regulation of the pressure and in the mean were 100.59° , 89.29° , 77.84° , 64.85° , 49.14° , 80.12° ; the corresponding latent heats were 588.25, 545.76, 552.47, 559.47, 569.55, 579.0, estimated with 4.188 joules to the 15°-calorie. The formula—

$$L = 598.8 - 0.5994t$$

represents the results for the five higher temperatures with a mean difference of 0.05 per cent., but varies by 0.3 per cent. from the result found for the lowest temperature: the formula—

$$L = 94.21(865 - t)^{0.2184},$$

while representing the five higher results with a mean difference of 0.08 per cent., differs by only 0.1 per cent. from the result for 80° , and moreover fits in better with thermodynamic requirements. Complete details are given of the apparatus and methods of measurement employed, as also of the corrections to be applied, and comparisons of these results with those of other observers are made. By assumption of Thiesen's values for the saturation-pressure and Linde's values for the saturation-specific volume

the specific heat of saturated steam and the isometric specific heat of nearly saturated steam are calculated for the above range of temperature by use of the ordinary thermodynamic formulæ. R. E. B.

433. *Specific Heat of Superheated Steam.* S. B. Bilbrough. (Eng. Rev. 16, pp. 104-124, Feb., 1907.)—Steam is generated in a boiler, then passed through a superheater to a double chamber divided into two parts by a throttling disc, and finally allowed to escape from the low-pressure side into the air. It was found that (1) if at atmospheric pressure the superheat is above 16°F ., or above $8\frac{1}{2}^{\circ}\text{F}$. at 150 lbs. per sq. in., the temperature of the wire-drawn steam is independent of its pressure; (2) for less superheats the temperature T of the wire-drawn steam rises with its pressure, but less rapidly than the corresponding saturation-temperature, so that its superheat diminishes. It is concluded that steam at degrees of superheat depending on the pressure is a more perfect gas than hydrogen; that in this state its specific heat is 0.805 (or 0.899 if Griffiths' expression for the total heat of saturated steam is more exact than Regnault's); that the specific heat increases enormously as the steam approaches saturation (the largest measured value being 88 times that of well-superheated steam). R. E. B.

434. I. *Specific Heats of Pure Alcohols and their Mixtures together and with Water.* II. *Heats of these Mixtures.* E. Bose. [Experimental work, I. with A. Müller and II. with M. Bose.] (Gesell. Wiss. Göttingen, Nachr., Math. phys. Klasse, 8, pp. 278-308, 309-384, 1906.)—These measurements were undertaken to provide material to test the relation deduced by Nernst between the heat of mixture and the vapour pressures of the components in the pure and mixed states. Observations were made in conjunction with A. Müller on the ethyl, propyl, and methyl alcohols, on their mixtures with water and on their mixtures with each other, and the specific heats of the mixtures found do not follow the proportional rule. These results were utilised in making further observations, in conjunction with Miss M. Bose, on the heats produced on formation of these mixtures; but the application to Nernst's formula has not yet been made. R. E. B.

435. *Specific Heats of Vacuum.* M. Brillouin. (Journ. de Physique, 6, pp. 84-87, Jan., 1907.)—From Wien's expression $(16T/8Q)d\theta/T^3$ for the heat required to alter the temperature and the volume between athermanous reflecting walls with black radiation, where $Q = 8 \times 10^{10}$ and $\sigma = 1.28 \times 10^{-12}$, the expression $0.88 \times 10^{-12} T^3$ is deduced for the isometric specific heat per c.c.m. of vacuum at T , and its values are compared with that (3.2×10^{-10}) of the most attenuated ordinary gases, i.e., at a millionth of an atmosphere. [But isometric has different meanings in the two cases, as is afterwards recognised.] Similarly for the isothermal heat of dilatation; and the adiabatic expansion of a gas, taking account of the radiation-energy in the volumes occupied by it, is discussed. R. E. B.

436. *New Method for detecting the Direction of Sluggish Heat-changes.* E. T. Allen, F. E. Wright, and J. K. Clement. (Amer. Journ. Sci. 21, pp. 885-498, Nov., 1906.)—The method is described in the course (p. 416) of the authors' paper on "Minerals of Composition, MgSiO_3 ," a purely mineralogical paper, and is based upon the idea that a substance in which transformation progresses so slowly that the accompanying heat-change

cannot be detected by the ordinary method, should show it plainly if the change could be forced to proceed with sufficient velocity. The heat-change would then be concentrated and become visible on the temperature-time curve. The rate of change depending on the temperature, and increasing rapidly with it, if the substance which is unstable at high temperatures be introduced into a furnace several hundred degrees above the lower limit of the unstable region, the heat change should be greatly accelerated. The apparatus employed consisted of an empty platinum crucible placed in an electric furnace and having a thermo-element (covered by a Pt. shoe) dipping into about the centre of the crucible and fixed in position. The furnace is brought to a constant high temperature (1,425–1,475° in the experiments with wollastonite and albite) and a weighed portion of the substance dropped into the crucible, after which temperature readings are made at half-minute intervals. The product of this first change is then introduced into the furnace in a second experiment, under the same conditions, and a second temperature curve determined. A comparison of the two curves will then show the direction of the heat-change, i.e., with evolution of heat the temperature rate will be accelerated; with absorption of heat, retarded.

L. H. W.

437. *Comparison of the Optical Scale of Temperature with that of the Nitrogen Thermometer up to 1,600°.* L. Holborn and S. Valentiner. (Ann. d. Physik, 22. 1. pp. 1–48, Dec. 28, 1906. Communication from the Physikal.-Techn. Reichsanstalt.)—This is the full paper corresponding to Abstract No. 80 (1907), but the formula for E therein given now appears as—

$$E = 80600 \log_{10} [1.3 + (t/1000)^2] - 1590$$

in the range 1,100° to 1,600° C. on the nitrogen scale, and the melting-points of platinum and palladium as 1,789° and 1,582° respectively.

R. E. B.

438. *Equipartition of Molecular Kinetic Energy.* M. Brillouin. (Journ. de Physique, 6. pp. 82–88, Jan., 1907.)—Boltzmann shows that the kinetic energy of a molecule can be expressed in the form $\frac{1}{2} \Sigma a_i^2$, where the momentoids r are functions of the moments q and the coefficients a are functions of the co-ordinates. Each momentoid corresponds to one degree of freedom of the molecule. He further concludes that for the so-called *ergodic* distributions the mean value of the kinetic energy for each momentoid is the same. The author, however, points out that his reasoning requires the momentoids to vary all between the same limits, and that the limits within which different momentoids may vary without rupture of the molecule may differ very largely, so that the conclusion cannot really be affirmed.

R. E. B.

439. *Planck's Theory of Radiation and the Theory of Specific Heat.* A. Einstein. (Ann. d. Physik, 22. 1. pp. 180–190, Dec. 28, 1906.)—In continuation of other papers [see Abstract No. 1228 (1906)] the relation between the mean energy of a Planck resonator and the temperature is found, and from this it appears that on Planck's theory the mechanism of transfer of energy between matter and ether by means of ions oscillating with given frequency must be such that the energy of an ion can never be other than zero or a multiple of a fixed amount of energy ϵ . This result is not in consonance with the ordinary kinetic theory of heat, and therefore,

if it is true, we should expect to find other contradictions between the kinetic theory and observation which can be removed by the considerations applied to the case of radiation. Thus, the simplest assumption regarding the heat-motion in solids leads to the expression $5.94n$ for the specific heat (in gm. calories) when there are n atoms in the molecule, and this, while approximately true for most elements, is not at all the case for C, B, Si, &c.; Planck's theory, however, leads to the expression $5.94 \Sigma (\alpha \operatorname{cosech} \alpha)^2$, where $\alpha \equiv N_e/2RT$, from which can be deduced an explanation of the variations, since the summation terms can have every value between 0 (for values of α greater than about 5) and 1 (for values of α less than about 0.5). The electrons oscillating (on Drude's theory) with ultra-violet frequencies will thus at ordinary temperatures contribute practically nothing to the specific heat, while the atoms which oscillate with infra-red frequencies contribute the more the longer their period. These ideas are considered in more detail and are applied to the case of diamond. R. E. B.

440. Mathematical Expression of the Second Law of Thermodynamics. F. Hasenöhr. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 1005-1008, July, 1906.)—A new method of showing dH/T to be a perfect differential is here proposed. That dH/T is a perfect differential follows from considering two engines, one performing a reversible cycle and the other so connected with it that their temperatures are always the same and each supplies what heat the other takes in. Then the impossibility of perpetual motion requires the second engine's cycle to be reversible, whence dv' , given by—

$$XdT + Ydv = dH = -dH' = -X'dT' - Y'dv' = -X'dT - Y'dv',$$

or—

$$-dv' = [(X + X')dT + Ydv]/Y'$$

is a perfect differential. This leads to the relation—

$$(\partial Y/\partial T - \partial X/\partial v)/Y = (\partial Y'/\partial T' - \partial X'/\partial v')/Y',$$

which, by reason of the independence of the engines, requires—

$$(\partial X/\partial v - \partial Y/\partial T)/Y$$

to have the same value for all bodies at the same temperature, and thus to be a function of the temperature alone. For a perfect gas, with a scale of temperature such that its characteristic is $p v/T = \text{const.}$, this expression has the value $1/T$, whence generally $(\partial/\partial v)(X/T) = (\partial/\partial T)(Y/T)$, or dH/T is a perfect differential. R. E. B.

REFERENCES.

441. Distillation and Desiccation in a Vacuum at Low Temperatures. d'Arsonval and Bordas. (Comptes Rendus, 143. pp. 567-570, Oct. 22, 1906.)—The authors describe a vacuum distillation apparatus in which the original vacuum is maintained during the whole course of the distillation, the vapour disengaged being condensed immediately by means of liquid air or a pasty mass of solid carbon dioxide and acetone. T. H. P.

442. The Determination of the Equivalence of Heat and Energy. T. Gross. (Elektrochem. Zeitschr. 18. pp. 195-199, Dec., 1906, and pp. 211-219, Jan., 1907.)—A discussion of the earliest experiments on which claim to the proof of this equivalence was founded; they are pronounced to be quite inadequate. R. E. B.

SOUND.

443. Monochord Vibrations. E. H. Barton and J. Penzer. (Phil. Mag. 12, pp. 576-578, Dec., 1906.)—Following upon the investigation of the simultaneous vibrations of the string and the belly of a monochord [see Abstract No. 1768 (1906)] the authors now deal with the simultaneous motion of the string and the air in the sound-box, both bowing and plucking being used. The motion of the air in and out of the sound-box was recorded "by placing a thin animal membrane over one of the central holes of the instrument, which had three on each side. In the centre of this membrane was attached by shellac and a strip of membrane one end of an aluminium stalk, whose other end was in like manner attached to a small plane mirror. This mirror rocked upon a horizontal axis, being mounted on a sewing-needle clipped to small brass brackets fastened on the vertical face of the sound-box. Now the mirror received, through a pin-hole in a sheet of tin-foil, the light from an electric arc-lamp, which, after reflection and passing through a lens, was focussed upon the upper part of the sensitive plate about 8 ft. distant." The figures show a greater complexity in the motion of the air than in that of the sound-box, the air being evidently able to follow more closely the complicated motion of the string. E. E. F.

444. Perception of Sound Direction. Rayleigh. (Phil. Mag. 18, pp. 214-232, Feb., 1907. Paper forming part of the Sidgwick Lecture, Cambridge, 1906.)—Some years ago the author executed an extensive series of experiments in order to ascertain more precisely what are the capabilities of the ears in estimating the direction of sounds. It appeared from these that, when the alternative was between right and left, the discrimination could be made with certainty and without moving the head, even although the sounds were pure tones. On the other hand, if the question was whether a sound were situated in front of or behind the observer, no pronouncement could be made in the case of pure tones. But with sounds of other character, and notably with the speaking voice, front and back could often be distinguished. The discrimination between the right and left situations of high sounds is easily explained upon the intensity theory, the head forming a fairly effective screen which places the averted ear in a sound shadow. But this theory becomes less and less adequate as the pitch falls. At a frequency of 256 the difference of intensities at the two ears is far from conspicuous. At 128 it is barely perceptible. But although the difference of intensities is so small, the discrimination of right and left is as easy as before. There is nothing surprising in the observation that sounds of low pitch are nearly as well heard with the further as with the nearer ear. When the wave-length amounts to several feet it is not to be expected that a sound originating at a distance could be limited to one side of the head. This subject has been quantitatively examined in the author's "Theory of Sound," § 82E, whence it appears that for a frequency of 256 the difference of intensities is only about 10 per cent. of the whole intensity. A fall in pitch of an octave reduces the difference of intensities 16 times. Thus at frequency 128 the difference would be decidedly less than

1 per cent. of the whole; and from this point on it is difficult to see how this difference could play any important part. The present paper contains an account of experiments carried out recently which have solved the above outstanding difficulty. By theory and experiments with forks it is concluded that above $c'' = 512$ the discrimination of right and left is made chiefly, if not solely, upon the difference of intensities at the two ears, but that at low pitch, at any rate below $c = 128$, phase-differences must be appealed to. To confirm this the obvious method was to conduct to the two ears separately two pure tones, nearly but not quite in unison. During the cycle, or beat, the phase-differences assume all possible values. This was realised by two forks of frequency 128, independently electrically maintained, placed in different rooms and isolated. The observer in a third room listened with each ear to the sounds along gas-pipes led through holes in a thick wall from the resonators associated with such fork. The beat could be slowed down until it occupied 40 or even 70 sec., thus giving opportunity for more leisurely observation. The results were quite decisive; it was found that if the vibration on the right were the quicker, the sensation of right followed agreement of phase and the sensation of left followed opposition of phase—that is, the sensation of receiving a sound from the right was experienced when the sound received at the right ear had a lead in phase over that reaching the left ear. The conclusion, no longer to be resisted, that when a sound of low pitch reaches the two ears with approximately equal intensities but with a phase-difference of one quarter-period, we are able so easily to distinguish at which ear the phase is in advance, must have far-reaching consequences in the theory of audition. It seems no longer possible to hold that the vibratory character of sound terminates at the outer ends of the nerves along which the communication with the brain is established. On the contrary, the processes in the nerve must themselves be vibratory, not of course in the gross mechanical sense, but with preservation of the period and retaining the characteristic of phase—a view advocated by Rutherford, in opposition to Helmholtz, as long ago as 1886. And when we admit that phase-differences at the two ears of tones in unison are easily recognised, we may be inclined to go further and find less difficulty in supposing that phase relations between a tone and its harmonics, presented to the same ear, are also recognisable. The discrimination of right and left in the case of sounds of frequency 128 and lower, so difficult to understand on the intensity theory, is now satisfactorily attributed to the phase-differences at the two ears. Observations with sounds of the frequency 256 are next dealt with, and it is concluded that when, by passing up in pitch, difference of phase fails, difference of intensity comes to our aid in the discrimination of right and left. In conclusion it is pointed out that, in wishing to locate a fog-signal heard on board a ship, a combination of three or four observers facing different ways offers advantages. A comparison of their judgments, attending only to what they think as to right and left and disregarding impressions as to front and back, should lead to a safe and fairly close estimate of direction.

E. H. B.

REFERENCE.

445. *Electrical Features of the Cahill Telharmonic System.* A. S. McAllister, (Electrical World, 49, pp. 22-24, Jan. 5, 1907.)—A more detailed, illustrated account of the apparatus described in Abstract No. 1262 (1906).

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

446. *Electromagnetic Mass of an Electron.* A. Righi. (N. Cimento, 12, pp. 247-266, Oct., 1906. R. Accad. Sci. dell' Istituto di Bologna, Mem. vol. 8, Ser. 6. Phys. Zeitschr. 8, pp. 161-169, March 15, 1907. Translation.)—

Attempts to formulate a more exact theory of the apparent mass of an electron by assuming it to have a certain small volume instead of being a mathematical point. The author supposes that the ether is incapable of supporting a strain exceeding a certain maximum strain, such as must exist at the surface of an electron smaller than a certain minimum size. The electron itself thus becomes a conductor instead of a dielectric. The author then shows that the surface of an electron at rest is spherical, but that of an electron in motion is spheroidal, the polar axis being $\rho_1 = \rho_0 \sqrt{1 - a^2}$, and the equatorial axis $\rho_2 = \rho_0 / \sqrt{1 - a^2}$, where ρ_0 is the axis when at rest, and a is the ratio v/V of the speed to the speed of light. The mass m of the electron in uniform rectilinear motion is given by—

$$m/m_0 = 1 + (88/80)a^2 + (159/560)a^4 + (57/256)a^6 + \dots,$$

where m_0 is the stationary mass. The following table gives, for various velocities (in cm.), the values of a , m , ρ_1 , and ρ_2 :—

v .	$a = v/V$.	m/m_0 .	$\rho_1 : \rho_0$.	$\rho_2 : \rho_0$.
0	0	1	1	1
12×10^9	0.04	1.000001	0.999	1.001
8×10^9	0.1	1.0041	0.995	1.008
10^{10}	0.33	1.050	0.948	1.092
2×10^{10}	0.66	1.259	0.745	1.554
2.7×10^{10}	0.9	7.876*	0.486	8.775
2.97×10^{10}	0.99	24.245*	0.141	18.874
8×10^{10}	1	∞	0	∞

The values marked with an asterisk are calculated from another formula giving a greater degree of approximation than the formula above quoted. The author points out that it is useless to compare the values of m/m_0 in the above table with those found experimentally by Kaufmann, since the calculation only holds good for uniform rectilinear motion, and Kaufmann's method introduces both magnetic and electrostatic deflection. The agreement between Thomson's theory and Kaufmann's results may possibly be accidental.

E. E. F.

447. *Ratio of Thermal and Electric Conductivities in Metals.* M. Reinganum. (Deutsch. Phys. Gesell., Verh. 8. 22, pp. 598-596, Nov. 30, 1906. Paper read before the 78 Naturforscherversammlung, Stuttgart, Sept. 20, 1906. Electrician, 58, p. 257, Nov. 30, 1906. Abstract.)—The electron theory is well known to lead to a value of the ratio of the thermal and electric conduc-

tivities of metals which is of the right order of magnitude. But in its simplest form this theory furnishes the same value of the above ratio for all metals, which is not in agreement with facts. The present author now plots graphs from the observations of Jaeger and Diesselhorst, the atomic weights being abscissæ, and the ratio of conductivities the ordinates. The curves thus obtained slope upwards to the right, and are convex upwards. And, speaking generally, the paramagnetic metals lie above the line and the diamagnetic ones below. Bismuth, however, is an exception, and lies well above, *above the line*. E. H. B.

448. *The Equations of the Electron Theory.* L. de la Rive. (Archives des Sciences, 22. pp. 209-215, Sept., and pp. 821-823, Oct., 1906. Phil. Mag. 18. pp. 279-285, Feb., 1907.)—The author first transforms Maxwell's equations into the following form—

$$\frac{1}{v^2} \frac{d^2 A}{dt^2} - \nabla^2 A = 4\pi\rho u \dots (1), \quad \frac{1}{v^2} \frac{d^2 \phi}{dt^2} - \nabla^2 \phi = 4\pi\rho v^2 \dots (2),$$

$$H = \text{curl } A \dots (3), \quad \text{and } D = \frac{1}{4\pi v^2} \frac{dA}{dt} - \frac{1}{4\pi v^2} \nabla \phi \dots (4).$$

Consider the point P_0 of the field at the instant t_0 , and suppose that the values ϕ and A have been propagated to it from the electron with the velocity of light v . They have therefore been emitted by the electron at an instant t such that the radius vector at that instant is given by $r = v(t_0 - t)$. If we regard t_0 as constant, the equations (1) and (2) may be written—

$$\frac{d^2 A}{dr^2} - \nabla^2 A = 4\pi\rho u \dots (5), \quad \text{and } \frac{d^2 \phi}{dr^2} - \nabla^2 \phi = 4\pi\rho v^2 \dots (6).$$

When both t_0 and t are variable we have $dr = v(dt_0 - dt)$. Let E and E' be two positions of the electron at the instants t and $t + dt$ of emission. The path EE' described by the electron is $u dt$, and on projecting it on the radius vector EP_0 we have $-dr = u dt \cos(ur)$, and thus $dt_0 = dt [1 - (u/v) \cos(ur)]$. The time t_0 is called the time of transmission, and the above relation shows that the ratio dt_0/dt is constant. This ratio may be termed "Doppler's factor." It is the ratio of the duration of a phenomenon of emission to the duration of the same phenomenon when transmitted, such duration being supposed sufficiently short in comparison with the time required by light to travel from E to P_0 . Its value is unity when the velocity of propagation is at right angles to the radius vector, since in that case the source of emission neither recedes nor approaches. If we suppose that the action of the electron in motion is due to an oscillatory state of the æther which is propagated with the velocity of light, the mathematical conditions are satisfied. The ratio dt_0/dt is found to be introduced as a denominator into the expression for the velocity of the oscillating mass, since Doppler's factor modifies the duration of the oscillation propagated. The momentum of the electromagnetic field fulfils the required conditions, and this involves the assumption that field intensity is in the nature of momentum. V. Bjerknes has previously shown, by considering the analogy between the steady electromagnetic field and the hydrodynamic field, that magnetic intensity in the one case is analogous to momentum in the other. A. R.

449. *Electron Theory of Matter and Radiation.* G. A. Schott. (Phil. Mag. 18. pp. 189-213, Feb., 1907.)—One of the most important problems of the electron theory of matter is to account for the spectra emitted by the

several elements; the solution of this problem, rather than of any other, seems likely to lead to the construction of a working model of the atom. For stability it is necessary to have both positive and negative charges, and one or both must be in more or less rapid motion. Since the atom is permanent, or very nearly so, the orbits of all the charges must be closed and of atomic dimensions; since it is electrically neutral, except when ionised, positive and negative charges must be present in equal amounts. In the present paper is studied the radiation from a ring of electrons in a controlling field, both when it is in steady motion and when it is disturbed. It is found that a single ring cannot be made to account for spectrum series or bands. It accordingly follows that the single ring cannot serve as a model of an atom, but its study throws light on the conditions which such a model must satisfy in order to account for spectra. These conditions are three in number: (1) The electromagnetic waves emitted by the disturbed ring and received by a stationary observer must be of sufficient intensity to give observable lines; (2) their frequencies must lie within the limits corresponding to the spectrum; (3) they must be given by a formula, such as that of Deslandres for bands, or those of Balmer, Rydberg, or Kayser and Runge for series, and this formula must be satisfied within very narrow limits for every line. It is shown that the single ring of electrons can only give rise to 18 observable lines, which is much too small to account for series or bands. The paper is too highly analytical for detailed abstraction, and should be referred to by those wishing to follow the exact line of argument. [See also Abstract No. 1749 (1906).] E. H. B.

450. *Barlow's Wheel*. L. Trafelli. (Elettricista, Rome, 6. pp. 1-2, Jan. 1, 1907.)—Defends the validity of Lagrange's equations as applied to the theory of Barlow's wheel, which Carvallo denies. The latter concludes that because the magnetic flux across the circuit closed by the radius of the wheel is zero, the mutual potential of the two circuits is zero, and the electrokinetic energy of the system is reduced to the sum of the two inductances. This reasoning fails, however, when one of the elements of the circuit is movable. Laplace's rule is then applicable to the movable portion as regards electromagnetic reactions, and Faraday's rule of the open circuit as regards the induction. When these rules are taken into account the equations of Lagrange agree with experiment. But the actual case is always complicated by the lateral electrical fluxes which are closed within the disc itself. The formula only becomes exact when the electric flux is supposed to be concentrated along the whole edge of the disc on the one hand, and at the centre of the disc on the other. This is precisely the case in a unipolar dynamo previously described by the author. E. E. F.

451. *Lightning Conductors*. A. Breydel. (Soc. Belge Élect., Bull. 23. pp. 471-478, Oct., 1906.)—The author suggests a rational system of lightning conductors for buildings. Each projection of a building should bear a band of copper or galvanised iron, all of which should be bound together by ties of the same metal, the whole system being earthed by as many vertical bands as possible, thus forming a sort of metallic cage with many projecting points. A. W.

452. *Electric Conductivity of Gases when Expanding*. L. Bloch. (Comptes Rendus, 148. pp. 1226-1227, Dec. 31, 1906.)—Compressed air, when allowed to expand under conditions that avoided electrification due to dust, showed

electrification of both kinds, which were of the same order of magnitude but with negative in preponderance. The phenomenon presents great irregularity, but the observations showed an average mobility of about 24 mm. per sec. for both positive and negative ions. Oxygen under similar circumstances shows also both kinds of electrification, but in sensibly equal amounts; the irregularity of the phenomenon is, however, so marked that the mobility of the ions can with difficulty be estimated, but it seems to be rather less than half of that for air. These values being about the same as those for ions in air after it has passed through water, the ionisation accompanying the expansion of gases may be due to their rushing through water condensed at the orifice.

R. E. B.

453. *Ionisation of the Air on the Säntis, Aug., 1905.* V. Conrad. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 1065-1079, July, 1906.)—The observatory on the Säntis, 2,000 m., is kept by the Schweizerische Meteorolog. Zentralanstalt. The author selected the Säntis for his observations, which he had formerly conducted on the Sonnblick, because the Säntis descends very steeply on the western side and seemed to be favourable for the study of the ascending and descending air-currents in their influence upon the ionisation. It would result, however, that much more simple conditions prevail on a mountain like the Sonnblick, which is covered with ice and surrounded by glaciers, and on which the ionisation of the air is not disturbed by emanations from the soil, than on the jagged Säntis, which was free from snow. On the Säntis the course of the diurnal variation in positive and in negative ions is very different. The variation of the positive ions depends chiefly on the emanation from the soil, and secondarily on the vertical convection currents; the opposite holds for the negative ions. These two causes would account for the observed phenomena. Observations were taken every two hours, each positive and negative double reading occupying half an hour; the weather was not favourable. Comparative measurements were made at the foot of the Säntis, in Wasserau. On the Säntis, the number of positive ions has its maximum at 11 a.m., of negative ions at 8 a.m.; the two minima coincide fairly, being at 8 and 2 p.m. respectively. The ionisation was determined with an Ebert aspiration apparatus made by Günther and Tegetmeyer; for the mobility determinations an auxiliary condenser of Mache was used.

H. B.

454. *Ionisation over the Ocean.* A. S. Eve. (Phil. Mag. 18. pp. 248-258, Feb., 1907.)—Boltzmann, using an Ebert's instrument during a voyage from Dover to New York, found the number of ions present per c.cm. to be $n_+ = 1150$, $n_- = 800$, ratio 1.5 [see Abstract No. 1025 (1905)]. These values do not differ materially from those which obtain in Germany, or Lapland, or Canada, and indicate that the ionisations at sea and on land are approximately the same in magnitude. The present paper contains an account of observations made during a voyage from Montreal to Liverpool (June 21-30, 1906), the weather being bright and very clear, and the sea moderate to smooth, with little or no spray in the air. An Ebert's instrument of the later pattern was used, and the following results were obtained: (i.) The ionisation of the atmosphere over the North Atlantic Ocean appears to be approximately the same in magnitude as in Europe or North America, the number of positive ions varying from 600 to 1,400 per c.cm. and the number of negative ions from 525 to 1,045 per c.cm. The ratio of the number of positive to the number of negative ions varies from 1.04 to 1.88. (ii.) The amount of radium

in sea-water is very minute, and is 1/500 to 1/2000 part of the average amount determined by Strutt in various sedimentary and igneous rocks. (iii.) Specimens of sea-water obtained from mid-Atlantic, and a sample of sea-salt, indicate that 1 gm. of sea-water contains about 5×10^{-16} gm. of radium [compare Abstract No. 422 (1907)]. (iv.) The emanation from the radium in sea-water, and the penetrating radiation from the active matter contained in it are insufficient to account for the ionisation observed over the ocean. (v.) Emanation arising from radium on land, and carried to sea by the wind, is the only known cause which will account for the ionisation effects observed over the ocean. The ionisation is larger than would be anticipated from such a cause, but it is possible that the rate of recombination of ions over the sea may be less than over the land. A. W.

DISCHARGE AND OSCILLATIONS.

455. *The Emanation from Phosphorus.* G. C. Schmidt. (Deutsch. Phys. Gesell., Verh. 8. 23. pp. 640-679, Dec. 15, 1906. Phys. Kabinet, Königsberg, Oct., 1906.)—After discussing and criticising the various hypotheses as to the facts connected with phosphorus emanation, put forth by Bloch, Harms, and others, the author states his own views and describes the experiments on which these are based. He considers that water plays the principal part in the whole process. The space in which dry oxides of phosphorus are suspended is a non-conductor, the space in which together with the phosphorus oxides water vapour also is present is a conductor, and in it a charged electroscope will lose its charge though the e.m.f. is very small. If water is allowed to drop into dry P_2O_5 the surrounding air becomes a conductor. By the action of H_2O on P_2O_5 the good conducting phosphorus acids are formed, and these produce the conductivity of the air. If, however, the water unites with the P_2O_5 without the formation of mist the air will not be ionised even although the reaction is powerful, but as soon as a fog is formed the air becomes a conductor. With excess of moisture the relation between e.m.f. and current is expressed by a straight line; with gradual drying a saturation current is attained, and this the sooner the less the moisture present. In general, experiment shows that the drier the air the saturation current is reached with ever smaller e.m.f.'s. According to the author's theory the passage of the electricity is entirely convective. His hypothesis is thus summarised: By the slow oxidation of phosphorus, at the most traces of ions originate. The conductivity arising through the oxidation is only an apparent one, which is produced by the convection of electricity by means of the solid conducting oxidation-products in the form of fog. The conducting particles are the phosphorus acids. J. J. S.

456. *New Phenomenon in the Positive Column of the Glow Discharge.* J. E. Lilienfeld. (Deutsch. Phys. Gesell., Verh. 8. 23. pp. 681-685 and 688, Dec. 15, 1906. Phys. Inst. d. Univ., Leipzig, Nov. 15, 1906.)—The author calls attention to a new kind of ordered motion of particles in vacuum tubes in which the electric discharge is taking place. It was observed when the vacuum was of the order of 0.01 mm. of mercury or under. A ruby-red fluorescence of the walls of the tube is produced often accompanied by intense heating of the glass surfaces. This appearance is noticed with the above pressure when the tube has been many times filled and refilled with oxygen after the gas has been pumped out. The direction of the motion of

the particles which give rise to this red fluorescence is shown by experiment to be from the cathode to the anode. The sense of the deviation caused by a magnet in the fluorescence shows that it is not due to negative particles.

J. J. S.

457. Anomalous Dispersion in the Positive Column of the Glow Discharge. J. E. Lilienfeld. (Deutsch. Phys. Gesell., Verh. 8. 23. pp. 687-689, Dec. 15, 1906. Phys. Inst. d. Univ., Leipzig, Nov. 1, 1906.)—Experiments were made to decide whether anomalous dispersion existed in the positive column of the glow discharge in vacuum tubes. The inquiry was made by means of the determination of the velocity of light in the positive glow in the case of homogeneous light of various spectral ranges; the method adopted depending on the observation of interference bands by means of a Jamin interferential refractometer. The discharge passed through two vacuum tubes 1 cm. wide, both sealed off at the same vacuum. The result was to indicate the absence of anomalous dispersion. The fact of the irreversibility of the spectral lines of Geissler tubes has been long known.

J. J. S.

458. Energy and Apparent Resistance of the Electric Spark. J. Koch. (Ann. d. Physik, 20. 8. pp. 601-605, June 28, 1906. Phys. Inst. d. Univ., Upsala.)—The author first refers to his former work [Abstract No. 802 (1905)], and then after consideration of Lindemann's expression for the mean spark resistance [Abstract No. 857 (1904)] and of Heydweiller's more recent results [Abstract No. 985 (1906)], is led to reiterate his former view that the apparent resistance of the spark with a continuous discharge and a large circuit resistance is very considerable; it is of a quite different order of magnitude to the average value of the same obtained with an oscillatory discharge and low-resistance leads. Two examples are given.

L. H. W.

459. Spark Discharge in Gases and Vapours. J. E. Almy. (Phys. Rev. 24. pp. 50-59, Jan., 1907.)—Röntgen has come to the conclusion that the minimum potential which will maintain a discharge between a point and a plane, placed a fixed distance apart, varies inversely as the mean free path of the gas molecules for different gases, if the pressure is kept constant. The author seeks to test this conclusion by determining the spark potential in different gases and vapours. Consideration of the data given by Paschen and Orgler shows that the quantity $(1/P) dv/dx$ is a function of the spark potential alone, being approximately constant for all pressures and spark-lengths, so long as the potential range used is the same. The value, α , of this constant is determined experimentally for various gases and organic vapours for potentials varying between 860 and 900 volts. The interpretation of the results is somewhat obscure, since decomposition of some of the vapours is caused by the discharge; nevertheless the author concludes that α is constant, λ being the free path, and that Röntgen's view is supported by experiment.

R. S. W.

460. Spark Potentials. M. Toepler. (Ann. d. Physik, 22. 1. pp. 119-128, Dec. 28, 1906.)—Very small values for spark potentials are obtained by multiplying Weicker's [Abstract No. 2568 (1905)] effective voltages by $\sqrt{2}$. The author has made a number of determinations in collaboration with Weicker, and finds that the apparent differences between his own and Weicker's spark potentials are due to the variation of the "vertex factor,"

which depends upon the voltage, but remains pretty constant at a value 1.58 after beginning at 1.40 for a low voltage. With small gaps (2 to 15 cm.) the spark potential is influenced by the glow discharge. The irregularity of the spark potential between 5 and 15 cm. is due to the sparking taking place sometimes near the glow limit, and sometimes near the brush limit. For larger gaps, exceeding 15 cm., the spark potential is identical with the limiting potential of the positive brush. E. E. F.

461. *Spark Potentials in Liquid Dielectrics.* P. E. Shaw. (Phil. Mag. 18, pp. 277-279, Feb. 1907.)—The author explains the reasons of the discrepancies between Earhart's results [Abstract No. 98 (1907)] and his own [see Abstract No. 1898 (1906)]. Earhart used an alternating p.d. of 60 frequency, whilst the author used direct p.d. The shapes and the materials of the electrodes were also different. Earhart found a "knee" on his curves; Shaw, by re-examining his own curves, finds indications of a "knee" for certain liquids but not for others. He thinks that the existence of a "knee" in the curve connecting the sparking potential with the distance between the electrodes separated by a liquid under the conditions of his own experiments very problematical. A. R.

462. *Absorption and Radiation of Hertz Waves by Metals.* J. v. Geitler. (Akad. Wiss. Wien, Sitz. Ber. 115, 2a, pp. 1081-1054, July, 1906. From the phys. Inst. der k.k. deutsch. Univ., Prag. Ann. d. Physik, 22, 2, pp. 246-264, Feb. 5, 1907. Abbreviated.)—Bjerknes has shown, for non-magnetic metals, that the damping produced in an electric wave places the metals in the same order in a series as does their electric resistance. As his results relate to one period only the author investigates how the ratio of the damping for the same pairs of metals depends on the period. It was thought that an anomalous absorption might be discovered, but this has not proved to be the case. A set of three similar resonators of copper, zinc, and German silver is used; they are thrown into oscillation by a neighbouring circuit and to their ends is joined a Hertz-Bjerknes electrometer. After a few oscillations of the rapidly damped primary circuit, the resonator oscillates freely and the p.d. at the electrometer plates is $\phi = B e^{-\beta t} \cos \delta t$. The electrometer throw is then proportional to $J = \int_0^{\infty} \phi^2 \cdot dt$, which gives $J = B^2/4\beta$ for values of β not too great. Hence for different resonators whose initial p.d.'s are equal $n = J/J' = \beta'/\beta$. The greater part of the paper is theoretical, and the author establishes the conditions upon which the radiating and absorbing powers depend. For wave-lengths greater than 2,400 cm. n for (German silver)/(copper) is constant, but increases for shorter waves. Zinc in place of copper gives similar results. R. S. W.

463. *Explanation of the Production of Undamped Oscillations in the Duddell-Poulsen Arc.* J. Sahulka. (Elektrotechnik u. Maschinenbau, 25, pp. 91-94, Feb. 8, 1907. Écl. Électr. 50 pp. 896-897, March 16, 1907, et seq.)—The author offers a simple explanation of the production of continuous oscillations, with the aid of the arc, which is in agreement with Duddell's conditions, and based upon experimental results to be communicated later. It is then pointed out that, as in the case of damped oscillations the ohmic resistance causes a lowering of the frequency owing to its damping influence, so also in the arc the ohmic resistance of the oscillatory shunt circuit must exert a damping effect; and hence the Thomson formula can

only hold approximately. The high-frequency current actually obtained from the direct-current arc consists of half-waves of equal amplitude, but each individual half-wave is damped; the fact that the resistance of the arc is not exactly the same during consecutive half-waves can, it is considered, exert some influence on the form of the half-waves. A few practical results are also quoted from the experiments. Thus in the case of an arc between a solid carbon and a cooled copper electrode in a coal-gas atmosphere, it was found possible to increase the resistance in the oscillatory circuit very considerably (up to 10 ohms), so long as the oscillatory circuit was previously excited; whilst if the circuit had been broken and remade, oscillations were only produced when the ohmic resistance was much reduced (< 4 ohms). The limiting resistance, therefore, depends upon whether the oscillatory circuit is already excited or not. Another point is that high-frequency currents are also set up in the choking coils in the direct-current circuit; and these currents generally have a somewhat different frequency to those in the oscillatory shunt circuit. To avoid this, it is advisable to make the direct-current self-inductances somewhat smaller and to include a self-inductance in series with the arc (also shunted by the oscillatory circuit), and of such value that the discharge paths through the arc and through the direct-current source correspond to the same frequency. As applied to wireless telegraphy the oscillations set up in these choking coils can be usefully employed to assist in the excitation (inductive) of the aerial circuit. L. H. W.

464. *Production of Undamped Oscillations.* Mosler. (Elektrotechn. Zeitschr. 28, p. 142, Feb. 14, 1907.)—The author has found that the effects obtained by Poulsen [Abstract No. 1620 (1905)] may also be produced by a purely mechanical method, viz., by directing against the arc a constant air-blast of suitable intensity. This throws the arc into oscillations, and these may be made to excite electrical oscillations in a suitably tuned circuit connected across the terminals of the arc. The best results were obtained by having the carbons in a horizontal position, using a voltage of 440, a current of 4 amps., and an arc-length of some 15 mm., with "effect" or flame carbons 5 mm. in diam. A disadvantage of this method of exciting oscillations lies in the fact that the frequency is variable within certain limits, rendering sharp tuning impossible. [See also Abstracts Nos. 1478b and 1474b (1906).]

A. H.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

465. *Electrical Behaviour of Selenium under the Influence of Heat and Light.* P. v. Schrott. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a, pp. 1081-1170, July, 1906. Phys. Zeitschr. 8, p. 42, Jan. 15, 1907. Abstract.)—The author has made an electrical examination of amorphous selenium, obtained by heating, of grey crystalline selenium prepared chemically from potassium selenide, of red selenium obtained by crystallisation from CS₂, and of the selenium modifications obtained by allowing amorphous red selenium to remain in contact with quinoline. The powdered selenium was in each case prepared for examination by pressing into a cylindrical form; the great pressure employed (10,000 kg./cm.²) changed the red precipitated selenium into the black vitreous modification. All the grey crystalline modifications prepared by heating from amorphous selenium were exceedingly labile, and showed even in one and the same preparation both positive and negative temperature-coefficients of resist-

ance. The sharp separation which Siemens makes between modifications I., II., and III. was found not to be justified; these forms pass over into one another. The forms denominated "hard" and "soft" by Ruhmer behaved similarly to the Siemens modifications I. and II. respectively. Selenium A (prepared from potassium selenide) is a non-conductor of the electric current, and is not sensitive to light; it is the ground form of grey crystalline selenium, and is stable at the ordinary temperature. On warming it changes partly into metallic selenium B, which conducts the electric current like a metal, and is the sole carrier of the sensibility to light. Red amorphous sulphur, after remaining for some time in quinoline, was sensitive to light and a conductor of electricity. On warming the red selenium crystallised from CS₂, it tended to form selenium B; the same tendency was observed when precipitated selenium was allowed to stand for about 14 days in contact with CS₂. At temperatures near the melting-point (about 210° C.) the sensitiveness to light of the above modifications disappeared; on subsequent cooling there was an increase of resistance on illuminating at temperatures down to 70°: at lower temperatures the phenomenon changed into a light-sensitiveness "of the second kind," as already observed by Siemens and Hesehus. In view of these facts Siemens and Hesehus's explanation of the light-sensitiveness of the second kind must be considered untenable. D. H. J.

466. *Photo-electric Fatigue*. W. Hallwachs. (Phys. Zeitschr. 7. pp. 766-770, Nov. 1, 1906. Paper read before the 78 Naturforscherversamml., Stuttgart, Sept. 16-22, 1906. Deutsch. Phys. Gesell., Verh. 8. 20. pp. 449-458, Oct. 30, 1906.)—An account is given of various researches upon the photo-electric phenomena observed when substances are exposed to the action of rays in gases at atmospheric pressure. The author states that on testing the various hypotheses as to the cause of the observed facts the only one that survives experimental inquiry is that which imputes the behaviour of the bodies examined to the absorption of gas in the surface layers of the substance. The storing of gas in the fine superficial pores of bodies must exert a great influence on the photo-electric discharge; the absorption susceptibility towards slow electrons exerts a decisive influence. The statement made that in an atmosphere of hydrogen no fatigue occurs would militate against this explanation, but in fact further experiment shows that fatigue does take place in the case of hydrogen, and that it is of the same order of magnitude as in air. The experiments first described are those in the case of fatigue in the absence of ozone. In the case of photo-electric fatigue brought on with ozone the same causes are at work, and the view attained goes back for an explanation of the fatigue within and outside vessels to the same origin, the absorption of the electrons by the absorbed gas. This is at any rate a factor in the phenomena of photo-electric fatigue, and the simplification and general view thus attained induces the placing of this explanation as the basis of further researches in photo-electric phenomena, and this will afford facilities for its fuller proof. J. J. S.

467. *A Source of Error in Thermo-electric Measurements*. F. Meissner. (Akad. Wiss. Wien, Sitz. Ber. 115. 2a. pp. 847-857, June, 1906. From the phys. Inst. d. k.k. deutsch. Univ., Prag.)—A very considerable difference was noted in the indications of various thermo-elements placed in electric furnaces, as compared with those of sensitive thermometers placed beside them. The differences were especially noticeable with copper wires: less so with iron. Change of conductivity takes place, and also alteration of the

surfaces, through oxidation. This is a source of error which should be carefully guarded against in thermoelectric observations. Readings were taken in porcelain tubes heated by the electric current, in hot-air baths and in a bath of oil of turpentine. J. J. S.

468. *Specific Inductive Capacity of Solutions of the Oleates of the Heavy Metals.* L. Kahlenberg and R. B. Anthony. (Journ. Chim. Physique, 4. pp. 858-864, 1906.)—The dielectric constant of concentrated solutions of the oleates of Mg, Zn, Al, Ni, Co, Fe, and Cd in benzene, C₆S, petroleum and various other solvents was measured by a modified Drude's method. The specific inductive capacity of the solvent is in general diminished by the addition of the oleates. But the influence is not additive, and the special character of the metal present has no measureable effect on the value of the dielectric constant. L. H. W.

469. *Sensitiveness in Resistance Measurements.* W. Jaeger. (Zeitschr. Instrumentenk. 26. pp. 860-862, Dec., 1906.)—The author refers to a paper by F. E. Smith [Abstract No. 2079 (1906)] in which this subject is dealt with, and points out that among the authors quoted, Schuster appears to be the only one who has handled the problem in a generally applicable and rigorous manner, by showing that the sensitiveness of the measurement of a resistance, R , through which a current, C , is passed, is proportional to $\sqrt{C/R}$. All the other authors quoted include in their expressions the resistance of the main circuit. Jaeger has independently arrived at the same result as Schuster, and he now gives a short discussion of the same. He says that it is to be hoped that the formulæ, in which occur the e.m.f. in the main circuit and its resistance, will now disappear from the text-books in favour of that of Schuster. J. D. C.

470. *Pirani's Method of Measuring Inductance.* O. de A. Silva. (Écl. Électr. 50. pp. 118-116, Jan. 26, 1907.)—In this method a condenser K , shunted by a non-inductive resistance, r , is placed in series with the coil whose inductance, L , is required. This combination is then placed as the fourth arm of a Wheatstone's bridge, and after the steady balance is obtained K is varied until there is no throw on closing the galvanometer key before the battery key. It is generally assumed from certain elementary considerations that $L = Kr^2$ in this case. The author works out the theory taking the inductance of the ballistic galvanometer into account. He obtains a linear differential equation of the third order. Without obtaining the individual values of the three roots of the auxiliary cubic, he shows that when there is a balance L is equal to Kr^2 . In fact we obtain the same expression for the variable discharge as when we neglect the inductance of the galvanometer. He points out that the case when two of the roots of the cubic are imaginary (representing an oscillatory discharge) wants special investigation. He assumes that the "internal resistance of the condenser" can be neglected. A. R.

471. *Standard Cells.* F. A. Wolff and C. E. Waters. (Electrical World, 49. pp. 100-101, Jan. 12, 1907. Abstract of paper read before the Amer. Phys. Soc., Dec., 1906.)—This is a brief account of work done at the Bureau of Standards to obtain data to serve as the basis of specifications for the construction of both Weston and Clark standard cells. Efforts were first

directed to the preparation of mercurous sulphate of uniform electromotive properties for which ten methods were employed. Chief attention was paid to the electrolytic method; of thirty-eight samples the greatest difference in e.m.f. of the cells set up is 40 microvolts. Many of the other methods appear to be equally satisfactory. Clark and Weston cells have been exchanged with Hulett, Carhart, Guthe, and Wold, and a maximum difference of 65 microvolts found; many of the small differences observed are probably due to some difference in the other materials employed. There is no tendency for a decrease in e.m.f. and it is thought that the e.m.f. of the Weston cell can be depended on as constant within 0.002 per cent. for at least six months.

472. Quadrant Electrometer. M. Moulin. (*Annal. Chim. Phys.* 10, pp. 98-104, Jan., 1907.)—The strength of a current can be measured by finding the velocity of deviation of the disc of a quadrant electrometer. This method which is often employed to measure the ionisation of gases, must be used with caution, as it supposes that the inertia and the damping of the moving disc are negligible. The author, making the suppositions that the quadrants are symmetrical round the axis of rotation, and neglecting the influences of the openings of the quadrants and the edges of the disc, finds and solves the differential equation of the motion taking the damping and inertia into account. He points out that if the quadrants are in the same horizontal plane, and if the upper quadrants are so close to the lower that the dimensions of the needle are large, compared with the distance between the upper and lower quadrants, the effects of the openings of the quadrants and the edges of the needle can be neglected. The *Compagnie des Compteurs* have made an electrometer in accordance with the specifications of the author. The maximum inaccuracy of this instrument is not greater than 0.5 per cent.

A. R.

473. A Ballistic Electrometer. F. Jacoviello. (*N. Cimento*, 12, pp. 855-868, Nov. and Dec., 1906.)—Let a rigid system be subject to the following conditions: (a) movable about a fixed axis; (b) having a stable position of equilibrium; (c) when displaced from equilibrium, being urged back by a force proportional to the angle of deviation; (d) being acted upon by a force proportional to the speed; (e) being at the zero at a time $t = 0$; and (f) being acted upon at the time $t = 0$, by forces acting for a very short time-interval, and which impart a certain velocity to the system. Then, whatever these forces may be, they are measured by the first maximum deflection. This has been applied to the ballistic galvanometer, but it can also be applied to the quadrant electrometer. Condition (c) is approximately fulfilled if the suspension is bifilar, and rigidly if it consists of a single wire. The author works out several methods of construction and measurement. By one of them, the capacities of two condensers can be conveniently compared.

E. E. F.

ALTERNATING CURRENTS AND MAGNETISM.

474. Foucault Currents in a Conducting Core within a Solenoid carrying Alternating Current. F. Piola. (*Accad. Lincei, Atti*, 16, pp. 85-48, Jan./6, 1907.)—The paper is a calculation of the distribution in amplitude and phase, of the magnetic induction in a conducting core for a sinusoidal current in the magnetising solenoid, the assumptions being made that the magnetic field is

everywhere parallel to the axis of the solenoid and that the permeability of the medium is constant. The results show clearly that the amplitude falls off rapidly on penetrating into the material, the more rapidly the higher the frequency, the permeability and the conductivity. Also, to obtain a similar distribution of flux with cylinders of different material for the same frequency it is necessary to make the section proportional to (resistivity)/(permeability). To produce the same effect with the same substance, varying the frequency, the section must vary inversely as the frequency.

476. Oscillatory Discharge. A. Battelli and L. Magri. (N. Cimento, 12, pp. 198-246, Oct., 1906.)—A résumé of previous work is given [see Abstracts Nos. 1761, 1762, and 1899 (1906), and 101, 116 (1907)] and the work is extended. Photographs of the hysteresis cycle are given, which show that the permeability is only very slightly affected by frequency, the curve retaining the same shape but having slightly less area up to a periodicity of 10,000 per sec. If, however, precautions to avoid eddy currents are not taken, the curve is very much distorted at high frequencies, and is elliptical in form. S. G. S.

476. Magnetostriction. D. O. S. Davies. (Nature, 75, p. 102, Nov. 29, 1906.)—Referring to the account given by Nagaoka of a lecture experiment on magnetostriction [Abstract No. 1818 (1904)], as well as to a similar description by W. S. Franklin, the writer of this note suggests the following explanation instead of that of helical magnetisation of the iron wire used: When a current enters at a pole and passes out at the centre of a freely suspended magnet, the magnet rotates about its axis. If, then, the current enters at one pole and passes out at the other, as both halves tend to rotate in opposite directions, one end of the magnet should be twisted relatively to the other. J. J. S.

477. Elastic Constants and Magnetisation. K. Honda and T. Terada. (Phil. Mag. 18, pp. 86-88, Jan., 1907.)—A continuance of the work so long associated with the staff and students of Tokio University [see Abstract No. 1120 (1906)]. It is a long experimental research with a vast number of curves and tables. The values of Young's modulus (M) and rigidity (n) are tested by various ways, (1) when the specimens are magnetised, and (2) when unmagnetised. It is found that magnetisation produces a change in the elastic constants in all cases. For Swedish iron and tungsten steel changes in M and n are very small and almost the same. For nickel the changes are as much as 15 per cent. for M and 7 per cent. for n . For nickel steels the effects are small for small percentage of nickel, and increase as the percentage increases. It should be noticed that there is considerable difference in the results according as the methods of measuring elasticity are direct or indirect. Also the extent of loading in measuring M influences the changes. If l be length or angle of twist, S the applied tension or couple, and H the magnetic field, the expression—

$$(\partial/\partial H)(\partial l/\partial S) = (\partial/\partial S)(\partial l/\partial H)$$

is found not to be strictly true. The authors point out that in magnetostriction and in Wiedemann's effect there are analogous differences in results according as stress or field is first applied. Remark is made on the fact that change in thermal expansion with magnetisation depends on temperature, and curves are given. P. E. S.

478. Behaviour of Iron under Small Periodic Magnetising Forces. J. M. Baldwin. (Phil. Mag. 18, pp. 232-248, Feb., 1907. Paper read before the Physical Soc., Oct. 26, 1906.)—The author here investigates the relations which obtain under actual working conditions between the amplitudes and phases of the different harmonics of the magnetic induction produced in iron, and those of the magnetic intensity producing it, for low values of the induction; and from the harmonic expressions obtained for these quantities deduces the loss of energy in the iron. Previous work on the subject has been performed under statical conditions, which are seldom realised in practice. Thus, for iron in the range $H = 0.88$ to 0.016 and using the ballistic method, Baur in 1880 found $B = 288$ to 8.8 and the permeability given by $\mu = a + bH$, where a and b were constants for the specimen. By extrapolation μ would tend to a definite limit, viz., 185, in exceedingly weak fields. Again, in 1887 Rayleigh with the compensated magnetometer method showed that, for unannealed iron, the permeability was appreciably constant over the range $H = 0.04$ to 0.00004 , while for values of $H > 0.04$ the expression $\mu = a + bH$ agreed well with experiment up to $H = 1.2$. The value of a for hard iron was 90 or 100. In the present series of experiments the magnetic intensity ranged from $H = 1.5$ to $H = 0.01$ and B from 600 to 2.5. Two specimens were experimented upon, in one of which (a bundle of iron wires) the eddy-current loss was comparatively small, while in the other (a rod of Lowmoor iron 0.8 sq. cm. in cross-section) the eddy-current loss was considerable. For the former specimen it was found that for very low inductions the lag of phase of the induction behind the magnetising force was very small, and also that the permeability was practically uninfluenced by the frequency of the alternations. In the latter, where the eddy currents were considerable, the resultant intensity inside the rod was not in phase with the current in the solenoid, and so the resultant induction always lagged behind the magnetising current. The experimental arrangements were like those previously used by T. R. Lyle, except that the iron ring and coils on it were here replaced by the straight specimens and solenoid. Lyle's wave-tracer was used to obtain the total iron loss. The detailed results are contained in elaborate tables and curves, of which only a few points can be noticed here as follows: (1) μ_0 diminishes with B_1 and tends to a finite value for very small values of B_1 , viz., 156 or 157. (2) μ_0 can be represented as a linear function of H , at low inductions, over a considerable range when eddy currents are small, and over a limited range when eddy currents are considerable. (3) The phase lag, θ , diminishes rapidly as B_1 diminishes, and tends to a limiting value at low inductions. (4) Where eddy currents are small, change of frequency has practically no influence on μ_0 and θ . (5) Where eddy currents are considerable, increase of frequency largely increases the total iron loss. E. H. B.

479. Magnetic Detectors and Effect of Electric Oscillations on Magnetism. C. Maurain. (Journ. de Physique, 6, pp. 5-25, Jan., 1907.)—In the first part of the paper the author attempts to show (1) that the sense of the effect of oscillations acting on a magnetic body under any given conditions can always be predicted, and (2) upon what the effect obtained depends quantitatively. The explanation is based upon the distance at such given time from the "normal curve of magnetisation," and is confined to the quite simple case of cyclic flux variation. It is considered that the explanation offered by some investigators, that the effect depends upon the value of dI/dH is insufficient and inaccurate, and compensated magnetometric experiments are described,

made always with the same cyclic amplitude, but first with very strong oscillations, next with weaker, and finally with very weak oscillations acting after the field change. The results plotted in the same way as Eccles' [Abstract No. 1619 (1906)] show maxima not at all coincident as regards distance along the H axis, the maximum being more displaced in the direction of increased field strength the weaker the oscillations employed. In the second part the author extends his investigation to the action in magnetic detectors of the Walter-Ewing type, thus including the more complex case when the magnetic body is placed in a rotating field. The case where the magnetic body is elongated, and hence the flux is of an alternating or cyclic nature, requires separate consideration from that in which the body is circular, as previously pointed out by Walter [Abstract No. 1290 (1905)]. In the first case, it is shown that if the oscillations act at two points only in the cycle as in Piola's experiments [Abstract No. 829 (1905)], the area of the hysteresis loop will be *increased* if these two points are the maxima of H, and *decreased* if the points correspond to $H=0$ [Peukert obtained a decrease with alternating current acting over the whole cycle or half-cycle (Abstract No. 854B (1905))]. In the case of the circular magnetic body the action of the oscillations is considered to depend on two sometimes oppositely directed effects [compare Abstract No. 1290 (1905)].

L. H. W.

480. *Magnetic Susceptibility of Solutions.* C. K. Studley. (Phys. Rev. 24, pp. 22-28, Jan., 1907.)—The susceptibility K of aqueous solutions of copper and magnesium sulphates is measured by a balance method used by Stearns. The values found are given below, where K' is the specific magnetism, or $K/Sp.Gr.$ —

Per Cent. Solution.	Specific Gravity.	$K \times 10^4$ (Measured).	K' (Calculated).	$K \times 10^4$ (Calculated).
Copper Sulphate ...	7.16	1.071	-0.084	0.002
	11.8	1.117	0.587	0.532
	8.94	1.082	0.212	0.199
	4.53	1.082	-0.270	-0.275
	9.48	1.089	-0.698	-0.767
Magnesium Sulphate	21.04	1.200	-0.823	-0.806
	12.40	1.118	-0.786	-0.778
	11.58	1.109	-0.789	-0.774
	8.95	1.084	-0.780	-0.765
	4.78	1.088	-0.765	-0.744

Stearns' value, -0.78×10^{-4} , for the susceptibility of water was employed. No temperature-coefficient was observed for these solutions between the temperatures 16° and $21^\circ C$.

G. E. A.

481. *Magnetic Disturbances at Batavia.* W. van Bemmelen. (Konink. Akad. Wetensch. Amsterdam, Versl. 15, pp. 250-262, Oct. 10, 1906. Proc., 9, pp. 266-278, Nov. 22, 1906.)—The author has prepared tables of all the magnetic disturbances observed at Batavia during the period 1880-1890, dividing them into two classes, sudden and gradual, according to their manner of occurrence. By the discussion of these sets independently various interesting facts are elucidated. During a magnetic storm, besides the sudden commencement and the increased agitation of the needle, there is evidence

that a force appears contrary to the earth's magnetic force, with the difference, however, that its horizontal component is directed along the meridians of the regular part of the earth's magnetism, consequently not pointing to the magnetic pole, but to the mean magnetic axis of the earth. Very striking also is the evidence showing that the starting impulse is received practically simultaneously all over the earth. There is a remarkable hourly distribution, showing that some relation exists involving the position of the station with respect to the sun. The agitation rises at about 8 a.m., after some hours of great calm, and reaches a maximum about noon. A second period of calm, less quiet, however, than in the early morning, is reached in the afternoon, and a second rise follows till a maximum is reached shortly before midnight. Comparison with the frequencies of sun-spots shows that the gradual storms do not indicate any correspondence, but that the sudden disturbances do agree to a certain extent. The discussion is continued with regard to the probable origin of the disturbances, being located in the streams of charged particles emanating from the sun. A. H. C. P. B.

ELECTRO-PHYSIOLOGY AND ELECTRO-THERAPEUTICS

482. *New Apparatus for Radiography. The Radio-corrector.* P. C. Petit, Boniface and Aubert. (Archives d'Él. Médicale, 14, pp. 942-954, Dec. 25, 1906.)—The apparatus, which is described in detail, is so arranged that the distance of the tube from the plate and the thickness of the part photographed are measured. Before taking a skiagram the most favourable distance of the tube is determined. This is done by observing the shadow on a screen placed in the same position as the plate, of a rod which marks the position of the part. The tube is adjusted until this shadow is clearly defined and occupies the centre of the screen. This rod is fixed to the upright portion of the apparatus by a sliding joint, and is used also in the measurement of the thickness of the object. Careful notes are kept of all the conditions under which the photograph is taken, so that it can be reproduced at any time.

H. W. P. Y.

483. *Coagulating Action of the Zinc Ion.* S. Leduc. (Archives d'Él. Médicale, 14, pp. 989-941, Dec. 25, 1906. Paper read before the Assoc. Franç. pour l'Avancement des Sciences at Lyons.)—When a current of 10 milliamps. is passed for 10 min. through a solution of albumen, the anode, if of zinc, becomes covered with a thick coating of albumen, but if a platinum anode is used little or no albumen is deposited. A similar result is obtained when the anode consists of a solution of zinc chloride contained in a glass tube closed by a membrane. After the coagulum has formed on the anode it becomes gradually disintegrated if the current be reversed.

H. W. P. Y.

484. *Determination of Quantity and Penetration of Röntgen Rays.* (Elektrotechnik u. Maschinenbau, 24, pp. 984-985, Dec. 2, 1906.)—Two methods of estimating the quantity of Röntgen rays are proposed by the firm of Reiniger, Gebbert, and Schall, of Erlangen. The first is a reinvention of Kienböck's method. In the second method (D.R.P. 174,952) a plate of graded superposed thicknesses of aluminium is placed in front of the film, each Al layer being of such thickness that it absorbs exactly as much of the radiation as does a given thickness of the tissue of a living body. In this way it is possible to ascertain the amount of radiation absorbed at the surface and at each

successive depth, i.e., how deep the penetration is; also by this means hard tubes are distinguishable from soft ones; the former give blackenings of small gradation, the latter sharp contrasts. A very similar method is suggested by C. Rôpique (Fr. Pat. 865,185), but in this case the aluminium is in the form of cones or pyramids of different height; and to secure a uniform basis of comparison each cone is surrounded by a flat silver ring, so that the shadows of different intensity cast by the cones are each surrounded by uniformly intense circular shadows. L. H. W.

485. *Influence of Number of Discharges on the Quantity of Röntgen Rays given off by a Tube.* H. Bordier. (Archives d'Él. Médicale, 15. pp. 22-26, Jan. 10, 1907.)—Using an interrupter fitted with a revolution-counter, the author has obtained experimental confirmation of the fact that the time required for a platinocyanide pastille [see Abstract No. 1441 (1906)] to reach a given tint when exposed to a Röntgen-ray tube, is inversely proportional to the number of interruptions (discharges) per min. through the tube. In three exposures, lasting 19 min., 18½ min., and 10½ min. respectively, the same tint was arrived at for a total number of discharges of 86,825, 87,057, 87,760 respectively. It is therefore necessary, besides stating the current employed and the quality of the rays, to give the number of discharges (in unit time). L. H. W.

REFERENCES.

486. *Positive and Negative Electrons.* H. A. Lorentz. (Amer. Phil. Soc., Philadelphia, Proc. 45. pp. 103-109, May-Sept., 1906.)—A brief discussion in which the question as to the choice between the theories involving (a) one kind only, or (b) two kinds of movable electrons, is dealt with. The Hall-effect, which appears at first sight strongly in favour of the "two fluids" theory, is to be examined to see whether it cannot be accounted for by the motion of negative electrons only. L. H. W.

487. *A General Solution of the Electromagnetic Relations.* J. W. Nicholson. (Phil. Mag. 13. pp. 259-265, Feb., 1907.)—An alternative solution of the differential equations of wave propagation to that of Lamb is developed. R. S. W.

488. *Impulsive Motion of Electrified Systems.* G. F. C. Searle. (Phil. Mag. 13. pp. 118-148, Jan., 1907.)—The paper is a mathematical one, and therefore unsuitable for abstraction. The magnetic and electric energies in the pulse produced by the sudden starting and stopping of electrified systems, or by sudden changes in their velocities, are calculated, together with the energy lost in the pulse and the momentum carried away by it. The following cases are dealt with: Sphere with uniform surface-charge, sphere with a uniform volume-charge, pair of concentric spheres with uniformly distributed complementary charges, sphere with surface density proportional to $\cos \theta$, ellipsoid of revolution with surface charge, circular disc moving in its own plane, and momentum and energy of a system of revolution moving slowly in any direction. R. S. W.

489. *Dissipation of Electricity.* J. Koenigsberger. (Phys. Zeitschr. 8. pp. 33-35, Jan. 15, 1907. Phys. Inst., Freiburg.)—Observations were made with a portable form of Elster and Geitel's apparatus on the rate of loss of charge for different bodies. The experiments were carried out on the sea at different places in the Atlantic, and on land in various parts of S. and N. America; near volcanoes and also underground. The results are compared with those of Ebert, v. Trautenberg, and Becker. A. W.

490. Ionisation and Radio-activity of the Air on the Pacific Ocean. F. Linke. (Gesell. Wiss. Göttingen, Nachr., Math.-phys. Klasse, 5, pp. 490-492, 1906.)—The author had intended to take observations on his way from Germany to Samoa, but owing to trouble with the Customs officials he did not obtain possession of his instruments until after leaving Honolulu. Particulars are given of observations made on Dec. 10 to 14, 1904, with instruments of the Elster-Geitel and Gerdien types. H. B.

491. Factors determining the Design of d'Arsonval Galvanometers. L. A. Freudenberger. (Electrical World, 48, pp. 959-960, Nov. 17, 1906.)—The shape and winding of the bobbin are dealt with.

492. Alternating-current Kelvin Galvanometer. W. S. Franklin and L. A. Freudenberger. (Phys. Rev. 24, pp. 37-41, Jan., 1907. Electrician, 58, pp. 654-655, Feb. 8, 1907.)—A much fuller account of the galvanometer described in Abstract No. 1914 (1906), with details of two further instruments. A. R.

493. Magnetic Induction. L. Orlando. (Accad. Lincei, Atti, 15, pp. 416-419, Oct. 7, and pp. 767-771, Dec. 16, 1906.)—A method of integrating the equation $\Delta^2(\phi) = 0$ by means of successive approximations is given, which is applicable in considering the magnetic induction in an isotropic body. In the second paper a more rapidly convergent series is obtained that is not merely limited to the case to which it is applied. S. G. S.

494. The Equivalent-spark in determining Hardness of Röntgen-ray Tubes. É. Henard. (Annal. Soc. Sci. de Bruxelles, 80, 3 and 4, pp. 189-190, 1905-1906.)—The author points out that the values generally given for the equivalent-spark are useless when the kind of discharge electrodes employed is not stated. He proposes that such measurements should always be made with spark-balls 22 mm. in diam., a size often employed. L. H. W.

495. Test of Kienböck's Quantimeter. Blythswood and W. A. Scoble. (Röntgen Soc., Journ. 3, pp. 86-88; Discussion, pp. 41-44, Dec., 1906.)—The accuracy of the method is experimentally investigated, and while found generally satisfactory the comparison of tints is held to be objectionable as opening the way to errors of considerable magnitude. L. H. W.

496. Direct Recording Declinograph. W. G. Cady. (Terrestrial Magnetism, 11, pp. 145-152, Sept., 1906.)—Detailed description of a portable declinograph, installed at the Solar Observatory on Mount Wilson, California, with which it is possible to watch the record and thus to get instant warning of the approach of a magnetic storm. The apparatus is arranged to permit of the record being observed from a distance by means of a telescope and mirror. C. P. B.

497. Magnetic Disturbances caused by Electric Tramcars Twelve Miles distant. L. A. Bauer. (Terrestrial Magnetism, 11, pp. 53-56, March, 1906.)—Observations at the Cheltenham (Maryland) Observatory.

498. Geodetic and Magnetic Survey of Madagascar. E. E. Colin. (Comptes Rendus, 142, pp. 1189-1141, May 21, and pp. 1179-1181, May 28, 1906.)—The author has completed the survey of the district of Tananarive commenced in 1903 [see Abstract No. 1804 (1904)], the triangulation covering 2,872 sq. km. with 805 stations, and the magnetic elements being determined in 49 more stations. The minimum declination of $7^\circ 48' 8''$ was observed on the granite mountains of Ambalomaranitra, the maximum of $12^\circ 24' 1''$ also on granite, 8 km. distant. There are three secondary centres of perturbations. At Alarobia the declination has decreased since 1903 by $18.5'$ the intensity by 0.00127, and the inclination has increased by $5'$. Details of the observations are given. H. B.

499. Evaporation of Solid Substances at Ordinary Temperature. II. C. Zenghells. (*Zeitschr. Phys. Chem.* 57. pp. 90-109, Oct. 23, 1906.)—Further experiments [see Abstract No. 616 (1905)] show that many salts, peroxides and hydroxides, the solid non-metals, and several metals volatilise appreciably at the ordinary temperature; lime, silver iodide, and calcium carbonate give negative results. The evaporation is favoured by the presence of moisture and by reducing the pressure. Silver has the specific property of absorbing the vapours, probably owing to the fact that the metal resists the oxidising action of the air and is, besides, a comparatively powerful reducing agent. When silver-leaf is placed in contact with one of the above-mentioned dry substances, it becomes attacked only at points not in contact with the substance. The metal is hence only acted on by the vapours of the substance which, in their rarefied condition, are probably dissociated; this view is supported by the phenomena of radio-activity. T. H. P.

500. Allotropic Silver and its Colours. F. E. Gallagher. (*Journ. Phys. Chem.* 10. pp. 701-714, Dec., 1906.)—An experimental investigation of the Christiansen-effect applied to colloidal silver was made. The method employed was to vary the refractive index of the liquid by means of other solvents and noting whether the colour-changes were in accord with theory. The colloidal silver was made by Carey Lea's method from silver nitrate by means of Rochelle salt and ferrous sulphate. The results obtained show that: (1) Colloidal silver solutions of all colours can easily be prepared from one set of reagents, by simply varying the conditions. (2) The colour-changes in colloidal silver solutions are not satisfactorily explained by the Christiansen refractive index phenomenon. A colour-change produced by increasing the refractive index of the liquid is not reversed when the refractive index is again diminished. (3) Light is essential to the changes of colour, and the velocity of these changes depends on the intensity of the light. (4) The colour of colloidal silver is due to a selective light absorption. The author concludes that there is only one form of colloidal silver, not several allotropic forms, and the various colours and properties, such as electrical conductivity, density, action towards reagents, are to be explained by the state of aggregation or number of the particles of this colloidal form. F. J. B.

501. Velocity of Diffusion of Electrolytes. G. Bruni and B. L. Vanzetti. (*Accad. Lincei, Atti*, 15. pp. 705-715, Dec. 2, 1906.)—Employing the method adopted by Buscaglioni and Purgotti, viz., allowing two salt solutions, which together give a precipitate, to penetrate from the opposite ends through a horizontal glass cylinder containing gelatine solution, and deducing their relative velocities of diffusion from the position where precipitation first occurs, the authors have investigated the combinations Ag_2SO_4 , BaCl_2 ; CuSO_4 , BaCl_2 ; and CuSO_4 , $\text{K}_4\text{Fe}(\text{CN})_6$, and, by following the progress of the colours, have examined the diffusion of CuSO_4 and $\text{K}_2\text{Cr}_2\text{O}_7$ solutions. The conclusions of Buscaglioni and Purgotti that the velocity of migration of the ions is almost entirely independent of the concentration, and that with solutions capable of giving two precipitates, two distinct points of precipita-

tion occur, are confirmed; but the latter phenomenon is regarded as more probably due to supersaturation than to any independent migration of the ions. The hypothesis that the ions have a velocity proportional to their square root is found to be untenable. Hydrolysis of coloured salts is well shown by their diffusion in gelatine. W. H. St.

502. *Augmentation and Reversal of Rotatory Power. I. Complex Molybdenum and Tungsten Malates.* H. Grossmann and H. Pötter. (Zeitschr. Phys. Chem. 56. pp. 577-604, Sept. 7, 1906. Chem. Inst. d. Univ., Münster.)—When sodium molybdate, $\text{Na}_2\text{MoO}_4 + 2\text{H}_2\text{O}$, is added to malic acid the initial levorotation -2° rises to a maximum -92.1° in presence of $\frac{1}{2}$ mol. of the molybdate, then falls to zero and rises to a positive maximum $+142.5^\circ$ in presence of 1 mol. of the molybdate, again falls to zero and rises to a negative maximum -15.8° in presence of 1.75 mol., and finally again falls to zero and rises to $+104.2^\circ$ in presence of 4 mols. of the molybdate. The tungstates give somewhat similar results. The observed changes are shown to depend on the presence of a series of compounds, which are discussed. T. M. L.

503. *Theory of Optical Rotation. II.* C. Winther. (Zeitschr. Phys. Chem. 56. pp. 703-718, Sept. 28, 1906.)—The validity of the formulae previously given [Abstract No. 1461 (1906)] is confirmed by a number of additional examples. In studying rotatory dispersion it is suggested that the ratio should be taken not of the actual rotatory powers, but of their temperature-coefficients when determined for lights of different colours; if the "solution dispersion coefficients" are proportional to these "rational dispersion coefficients," it is suggested as probable that additive compounds are not formed in the solution. T. M. L.

504. *Direct Union of Carbon and Hydrogen at High Temperatures.* J. N. Pring and R. S. Hutton. (Chem. Soc., Journ. 89. pp. 1591-1601, Nov., 1906.)—When carbon is heated in hydrogen, traces of acetylene are formed at $1,700^\circ$, and the quantity of acetylene then increases proportionally with the temperature up to $2,800^\circ$. Methane is formed only in very small quantities between $1,000^\circ$ and $2,800^\circ$, and its amount diminishes as the purity of the carbon is increased. T. H. P.

505. *Action of Hydrogen on Silicon and Silica.* A. Dufour. (Annal. Chim. Phys. 9. pp. 433-474, Dec., 1906.)—Small quantities of silicon hydride, SiH_4 , may be prepared from its elements (1) by passing dry hydrogen over silicon heated, in a silica tube, to beyond its melting-point by means of a blowpipe, and (2) by producing an electric arc between silicon electrodes in a current of hydrogen. After passing over the silicon, the gas must be rapidly cooled, the exit tube being reduced for this purpose to a very narrow diameter and connecting with a coil cooled by immersion in water. The silicon hydride is separated from hydrogen by subjecting the mixed gases to a pressure of 20 atmos. in a bath of liquid air, when the silicon hydride condenses on the sides of the containing vessel. Its boiling-point, determined thermoelectrically, is between -115° and -116°C , under a pressure of 72-76 cm. Hg. Silicon hydride is also formed together with water, when hydrogen is passed through silica tubes heated to their melting-point—a reaction which is reversed at lower temperatures. It is shown that the

apparent volatilisation of Si in an atmosphere of hydrogen in Geissler tubes containing SiH_4 is not due to any mechanical transference or distillation, but must be attributed to the decomposition and recombination of the SiH_4 .

506. Action on Metals of Moist Air in presence of Carbon Dioxide and Sulphur Dioxide. J. Rothe and F. W. Hinrichsen. (Königl. Materialprüfungsamt, Mitt. 24. 6. pp. 275-277, 1906.)—When bombs containing CO_2 or SO_2 are used for putting out local outbreaks of fire, it is possible that the after-effects of these gases on the metals of the building (or ship) may be serious. The authors have investigated the effect of (1) moist air, (2) moist air + 5 per cent. CO_2 , (3) moist air + 25 per cent. CO_2 , (4) moist air + 5 per cent. SO_2 , and (5) moist air + 0.5 per cent. SO_2 , on the following metals: cast iron, wrought iron, zinc (cast), lead, copper, brass, bronze (90Cu : 10Sn), an alloy containing 20Cu : 2Zn : 1Sn, yellow metal (brass containing iron and manganese), and German silver. All the experiments were carried out at ordinary room temperature. The results show that only in the case of SO_2 are the metals seriously affected. Even the 25 per cent. CO_2 mixtures do not occasion more rusting than moist air alone. In the experiments with SO_2 all the gas had disappeared within 48 hours, but the "rusting" still proceeded rapidly, once the surface of the metals had been attacked; and also T. S. P.

507. Rusting of Iron. J. N. Friend. (Nature, 74. p. 540, Sept. 27, 1906.)—Pieces of cast iron, wrought iron, and pure iron were sealed up in vessels containing water and air only; the water had been well boiled to get rid of dissolved CO_2 , and the pieces of iron were all polished. After keeping for several months the wrought iron and pure iron were unchanged, but the cast iron turned a shade darker in tint. Pure iron remained perfectly bright in a solution of hydrogen peroxide, a slow stream of oxygen being evolved; after some hours an odd speck or two of rust appeared. The wrought iron decomposed the peroxide rather more rapidly and the specks of rust were more numerous. The cast iron was covered with rust in a few min., the peroxide being decomposed very rapidly. The author thinks it possible that oxygen and water alone are sufficient to cause the impurer forms of iron to rust. [See also Abstract No. 198 (1906).] G. T. Moody (Ibid. p. 564, Oct. 4, 1906) considers that Friend's results confirm his own experiments which led him to consider that rusting is primarily a case of acid attack. T. S. P.

508. Winkler's Relation between Viscosity and Gas Absorption. M. Trautz and H. Henning. (Zeitschr. Phys. Chem. 57. pp. 251-264, Nov. 20, 1906. Chem. Laborat. d. Univ., Freiburg.)—Winkler's relationship between viscosity and gas-absorption could not be confirmed by a detailed examination of the data available for the solubility in water of hydrogen, nitrogen, carbonic oxide, oxygen, nitric oxide, hydrogen sulphide, and ammonia. In some cases Winkler's function remains fairly constant, but in most cases the values increase greatly at higher temperatures. T. M. L.

509. Studies in Chemical Affinity. I. and II. J. N. Brönsted. (Zeitschr. Phys. Chem. 55. pp. 871-882, April 18; and 56. pp. 645-685, Sept. 28, 1906. From d. kgl. danske Vidensk. Selsk. Skrifter, 7. R., Nat. og. math. Afd. II., 8. 1904, and 6. 1906.)—I. The author calculates thermodynamically the affinity of, that is the maximum external work obtainable from, a reaction in the case

by the application of modern physico-chemical methods under the very different ranges of temperature (and pressure) which govern the formation and crystallisation of minerals. In the present paper an attempt has been made to plot a complete melting-point curve for the lime-silica series and to determine the transition-temperatures of the different solid compounds that may be formed. The data for lime are uncertain, owing to its high melting-point; the relative density of lime after fusing by means of an arc is 8.816 at 25°/25°; it crystallises in the cubic system and possesses no polymorphic forms. The melting-point of quartz is difficult to determine, owing to the excessive viscosity of the product; melting does not take place at 1,550°, but was clearly established after heating 20 min. at 1,625°; 1,600° is taken as a provisional value for the melting-point. Both quartz and amorphous silica change to tridymite above 1,000°, so that quartz is evidently a labile form at high temperatures; on the other hand, in presence of vanadic acid, sodium tungstate, or a mixture of potassium and lithium chlorides, the amorphous material passes into quartz, tridymite being formed only at 800° or above. There is evidently an inversion-point (quartz $\rightleftharpoons$ tridymite) at about 800°, and the melting temperature of silica is therefore properly the melting-point of tridymite, and not of quartz, as is commonly stated; if rapidly heated quartz may melt directly without previous inversion, but it is not possible to determine a separate melting-point. The relative densities are—quartz 2.654, glass 2.213, tridymite 2.822 at 25°/25°. By heating a series of intimate mixtures on a platinum ribbon and noting the order of melting, the presence was established of eutectics at 68 per cent. SiO_2 , 87 per cent. CaO , and 46 per cent. SiO_2 , 54 per cent. CaO . The melting-points of mixtures containing more than 60 per cent. CaO are above the melting-point of platinum, but with an iridium ribbon a third sharp eutectic was detected at 82½ per cent. SiO_2 , 67½ per cent. CaO . The three eutectic temperatures were subsequently found to be at 1,417°, 1,480°, and 2,015°. Maximum melting-points were detected at 48 and 65 per cent. CaO , corresponding with the composition of calcium metasilicate, CaSiO_3 (which occurs naturally as the mineral wollastonite), and of calcium orthosilicate, Ca_2SiO_4 . Both of the compounds formed from the melt are polymorphous. The metasilicate, which melts at 1,512°, solidifies to a pseudo-hexagonal form, and inverts into wollastonite at 1,200°. The orthosilicate, which melts at 2,080°, shows three forms; the monoclinic α -form has density 8.27 and passes at 1,410° into the orthorhombic β -form; this has density 8.28 and passes at 675° into the monoclinic γ -form of density 2.97. The large change of volume which accompanies the latter change accounts for the disintegration which so frequently occurs in mixtures containing more than 61 per cent. CaO .

T. M. L.

513. *Fusing Quartz*. (D.R.-P. 179,570. Zeitschr. Elektrochem. 13. p. 44, Feb. 8, 1907. Abstract.)—W. C. Heraeus proposes to melt quartz and crystal in furnaces of zirconia or thoria, instead of his iridium furnaces. The iridium is expensive, evaporates, and the quartz adheres to it. The melting-point of zirconia lies 100° C. higher than that of quartz, and the two substances do not combine, while the oxides of Mg, Ca, Al, Yb, Ce form silicates at high temperatures and are hence unsuitable.

H. B.

514. *Bismuth-Thallium Alloys*. M. Chikashigé. (Zeitschr. Anorg. Chem. 51. 8. pp. 828-835, Dec. 8, 1906. Metallog. Communication from the Inst. f. anorgan. Chemie d. Univ., Göttingen.)—Gives a complete solidification diagram for these alloys and also a portion of the other equilibrium curves

The compound Bi_3Th_5 , solidifying at 211.7°C ., is indicated. Maxima at 88.75 and 98.5 per cent. Th are shown not to correspond to any definite compounds. With 20 per cent. Th there is formed the eutectic of Bi and Bi_3Th_5 , solidifying at about 198° , and between 37 and 70 per cent. Th there is another eutectic solidifying at 185.9° and containing 58 per cent. Th. The liquidus between the 88.75 per cent. maximum and the 98 per cent. minimum is shown to be a double line. The compound BiTh_3 separates out at 90° from the mixed crystals between 74.6 and 68.8 per cent. Th. F. R.

515. *Alloys of Palladium with Copper.* R. Ruer. (Zeitschr. Anorg. Chem. 51. 2, pp. 228-280, Nov. 18, 1906. Inst. f. anorg. Chemie, Göttingen, Aug., 1906.)—The melting-point curves of mixtures of palladium and copper show that these metals form a continuous series of mixed crystals. Crystal sections containing from 30 to 70 per cent. Pd, when etched with diluted aqua regia, exhibit radially-arranged, acicular crystals, the nature of which is not yet determined. T. H. P.

516. *Acetate Copper ("Allotropic" Copper).* C. Benedicks. (Metallurgie, 4, pp. 5-17, Jan. 8, and pp. 33-44, Jan. 22, 1907.)—Describes a series of experiments which prove that the peculiar properties of the metal obtained by electrolysis of copper acetate, ascribed by P. Schützenberger (Comptes Rendus, 86, p. 1265, 1878) to an allotropic modification of copper, are due to the presence of acetic acid in solid solution in the copper, from 0.62 to 1.72 per cent. being observed. The following are the reasons for the view that the acetic acid is held in solid solution, and not merely mechanically mixed. The microscope shows no inclosures in freshly polished specimens, although later oxidation commences at various centres. The specific volume increases by 0.0080 c.cm., at most, per 0.5 per cent. C ($1.25 \text{ C}_2\text{H}_3\text{O}_2$). If this were only mechanically mixed it would cause an increase of 0.0106 c.cm.—the difference being beyond the order of errors. The very high electrical resistance, considerable hardness, properties under stress, and reaction with HNO_3 , also indicate that the acetic acid is in solid solution. Further, if acetic acid were only held mechanically, it would be expected that high velocity of kathode, which undoubtedly gives denser metal, would also result in low acetic acid content—whereas the opposite is the case. Low temperature of electrolyte appears to favour a high acetic acid content. Higher temperatures, and higher velocities of kathode, increase the susceptibility of the deposited metal to oxidation in the air. F. R.

517. *Zinc-Iron Alloys.* S. Wologdine. (Soc. d'Encouragement. Rev. de Metallurgie, Mém. 8, pp. 539-546, Dec. 1, 1906. Metallurgie, 4, pp. 59-60, Jan. 22, 1907. Abstract.)—The author's experiments lead to the conclusions that iron is very soluble in molten zinc, so long as Fe does not exceed 8 per cent. Up to 10 per cent. Fe, the limit of the experiments, there are no solid solutions. A fairly well marked compound occurs; analysis gave 8.14 per cent. Zn; FeZn_{16} requires 7.88 per cent. Zn. The solidification temperature rises with increasing Fe, up to about 750°C . at the composition of the compound. The separation of pure Zn up to about 5.5 per cent. Zn was observed. A eutectic probably occurs at about 10 per cent. Zn (700°). F. R.

518. *Tempering and Cutting Tests of High-speed Steels.* H. C. H. Carpenter. (Iron and Steel Inst., Journ. 71, pp. 377-396, 1906. Mech.

Eng. 18. pp. 164-170, Aug. 4, 1906. *Metallurgie*, 8. pp. 511-522, Aug. 8, 1906.)

—An investigation of the effects of heat treatments, particularly tempering, upon some of the steels referred to in Abstract No. 1802 (1905). After air-blast quenching from $1,200^{\circ}\text{C}$, steels were reheated to various temperatures and structures observed. With carbon contents 1.81 to 0.55, Cr 1.8 to 8.7, W 0 to 13.5 and Mo 10.87 to 0; no tempering occurred below 550°C , and tempering was complete at from 600° to 700° . Results with two steels, one of which contained Cr and W, the other Cr and Mo, showed that the higher the air-quenching temperature the larger is the polyhedral structure, the longer the time required for etching, and the higher the temperatures at which tempering occurs, until the quenching temperature exceeds that at which the lowering and splitting of the critical ranges is brought about, when little further effect upon the tempering temperatures results. Quenching in solder was found to be less effective than in the air-blast; and so also was Gledhill's method, viz., cooling in air-blast to 920°C , and then in rape oil. Further work, including cutting tests, on a steel of composition not hitherto recognised as suitable for high-speed cutting, gave promising results. The composition was C 0.48, Mn 0.172, Cr 8.108, Mo 4.172, which is a less costly composition than ordinary high-speed steels. Cooled in three hours from $1,200^{\circ}$, the steel was only partially tempered. After air-quenching from $1,900^{\circ}\text{C}$, there was very little tempering effect by reheating to 800°C . F. R.

Studies in process following the above mentioned abstracts and experiments.

519. *Constitution of Iron-Carbon Alloys*. A. Sauveur. (*Iron and Steel Inst.*, Journ. 72. pp. 498-519; Correspondence, pp. 520-575, 1906. *Amer. Inst. Mining Engineers*, Bull. 12. pp. 989-996, Nov., 1906. Joint Meeting Paper. *Mech. Eng.* 18. pp. 878-881, Sept. 15, and pp. 420-425, Sept. 22, 1906. *Metallurgie*, 8. pp. 489-504, Aug. 8, 1906.)—A general discussion of the Roozeboom diagram. Experimental evidence is given to show that the $1,000^{\circ}$ line above 2 per cent. carbon does not correspond to the formation of cementite, but that graphite is only retained in solution by lag during cooling. Another view put forward is that austenite, martensite, troostite and pearlite are logically, respectively, solid solution of carbon in γ -iron, solid solution of carbon in β -iron, solid solution of carbon in α -iron, and iron- Fe_3C eutectic. F. R.

Studies in process following the above mentioned abstracts and experiments.

520. *Lower Limit of the Range A₂*. F. Osmond. (*Soc. d'Encouragement. Rev. de Métallurgie*, Mém. 8. pp. 411-417, Dec. 1, 1906.)—Fournel's results [Abstract No. 1684 (1906)] lead the author to support one of Fournel's conclusions, viz., that the sudden change observed in the electrical conductivity is due to the appearance of β -iron, and gives a sharper demarcation of the lower limit of the A₂ range than any other property has yet been found to do. He also considers that these experiments give additional support to the view that the added elements in self-hardening steels cause the presence of β -iron in them, and hence their hardness, at ordinary temperatures, by lowering the A₂ range. These ideas are illustrated graphically. The lower limit of A₂, as shown by Fournel's experiments, also coincides with the appearance of blue-heat brittleness. This may be explained as being due to the presence of β -iron at temperatures which are too low to soften it considerably. F. R.

521. *Nickel-Silicon Steels*. L. Guillet. (*Soc. d'Encouragement. Rev. de Métallurgie*, Mém. 8. pp. 418-427, Dec. 1, 1906.)—The author's experiments on steels containing 0.2 and 0.8 per cent. C, 0 to 6 per cent. Si, and 2, 12, and

80 per cent. Ni show that the properties of the steels are largely a combination of the properties of Ni steels and of Si steels. There are seven groups: pearlitic, pearlitic with graphite, carbon entirely graphitic, martensitic, martensitic with graphite and with or without ferrite, γ -iron, γ -iron and graphite, with or without ferrite and martensite. In the γ -iron steels, even in the absence of graphite, white grains appear which are probably a silicide. Si tends to lower a steel of given Ni content from the γ -iron to the martensitic class, but at the same time its effect is to retard the formation of martensite. Ni tends to hinder the tendency of Si to precipitate graphite. Prolonged annealing at 900° has little effect on the carbon condition of Ni-Si steels. The effect of Si on the mechanical properties of Ni steels is to reduce elongation and resistance to shock, especially across the direction of rolling, whilst increasing the elastic limit and tensile strength. Quenching the pearlitic steels from 850° hardens them enormously, the resistance to shock in the direction of rolling being high, but across practically nil. The addition of more than 2 per cent. of Si to Ni steels is not to be recommended for practical purposes, chiefly on account of the brittleness to which it gives rise. P. R.

522. *Influence of Silicon on Iron-Carbon Alloys.* F. Wüst and O. Petersen. (Metallurgie, 8. pp. 811-820, Dec. 22, 1906. Communication from the eisenhüttenmänn. Inst. d. kgl. techn. Hochschule, Aachen.)—The authors made specimens by heating Swedish cast iron with excess of carbon, and afterwards with more or less ferro-silicon. A portion was afterwards held for some time at 10° above the solidification temperature. The ratio of the difference between 4B and the total carbon to the Si content is found to be very roughly constant, averaging 0.808 between 2 and 5 per cent. Si, falling to about 0.18 at 18 per cent., and 0.18 at 27 per cent. Si. This ratio is interpreted as the amount of C displaced by 1 per cent. Si, the solidification temperature being taken as that of the eutectic for the given amount of Si, and the alloy as being saturated with C under the given conditions. With increasing Si the solidification temperature is gradually raised from 1,180° to about 1,245° with 27 per cent. Si. The effect is so slight within practical limits of working that it may generally be neglected. The duration of the change has an inverse relationship to the amount of graphite in the specimen. The metallographic study supports the probable existence of Fe_3Si —either free, or as Fe_3Si -rich solution in iron containing also some carbon. F. R.

523. *Relation between Composition and Properties of Malleable Cast Iron.* F. Wüst. (Metallurgie, 4. pp. 45-58, Jan. 22, 1907. Communication from the eisenhüttenmänn. Inst. d. kgl. techn. Hochschule, Aachen.)—It is found as a result of the author's experiments that the soundness of malleable cast iron is independent of the Si, P, and S contents, so long as these do not exceed 1.2, 0.1 and 0.2 per cent. respectively. If cementite is decomposed in the annealing process, then the soundness is more or less affected according to the amount of temper carbon oxidised out. The ductility and tensile strength are reduced with increase of S beyond 0.15 per cent. A repetition of the annealing process does not bring about any change in soundness and ductility, but it is found to be possible to increase the tensile strength by this means. F. R.

524. *Etching Reagents for Steel.* M. Kourbatoff. (Soc. d'Encouragement. Rev. de Métallurgie, Mém. 8. p. 489, Dec. 1, 1906.)—Points out that the reason why limited success has attended the use of the etching solution consisting of

equal parts of (a) 4 per cent. solution of HNO_3 in acetic anhydride, (b) methyl, (c) ethyl, and (d) isoamylic alcohols, is that acetic acid has been confused with the anhydride by several of those who have tried to make use of the formula. Two stock solutions can be used, the first consisting of (a), the second of (b) (c) and (d), which are mixed in the proportion of 1:8 immediately before use. Using HNO_3 of 1.82 density, sorbite and troostite are not coloured in less than 10 min. whilst the grain junctions of the other constituents readily appear.

F. R.

526. *Colour of Liquid Crystals.* O. Lehmann. (Phys. Zeitschr. 7, pp. 578-584, Aug. 15, 1906.)—If a substance which shows the phenomenon of liquid crystals is melted on a microscope slide and covered with a cover-glass, a bluish-green shimmer develops when the liquid-crystalline state is reached. This appears to be due merely to the opalescence of the material, but subsequently other colours are developed, changing from violet-blue through green and yellow to red, disappearing suddenly when the mass solidifies. Cholesteryl caproate is remarkable in that it exists in two liquid-crystalline modifications.

526. *Photo-chemistry and the Phase Rule.* W. D. Bancroft. (Journ. Phys. Chem. 10, pp. 721-728, Dec., 1906.)—The author points out that in reversible photochemical processes, light acts as a variable, in addition to pressure or concentration and temperature, so that $n+3$ phases are required for an invariant system. Solubility curves are worked out for a substance the transformation of which into another modification is affected by light, and good agreement between the theoretical curves and those obtained experimentally, has been found in the case of sulphur in carbon disulphide.

527. *Decomposition of Nitrites.* R. Abegg. [Experimental work by H. Pick.] (Zeitschr. Elektrochem. 12, pp. 592-598, Aug. 10, 1906. Paper read before the 18 Hauptversamml. der Deutsch. Bunsen-Gesell. in Dresden.)—The authors investigated the spontaneous decomposition of silver nitrite. The decomposition takes place as indicated by the equation $2\text{AgNO}_2 = \text{AgNO}_3 + \text{NO} + \text{Ag}$. (1). A saturated solution of AgNO_2 was heated in a closed vessel and the pressure of the NO measured. At 55° the NO pressure was 4.28 atmos., and at 65° 6.29 atmos. On again cooling to 55° the NO pressure was 4.28 atmos. The reaction is therefore reversible, and under certain conditions of pressure nitrites can be converted into nitrites by NO. The constant for the reaction $\text{Ag} + 2\text{NO} \rightleftharpoons \text{Ag} + \text{NO} + \text{NO}_2 \dots (2)$, $k = p_{\text{NO}} \cdot (\text{NO}_2) / (\text{Ag}) \cdot (\text{NO})^2$ at 55° , was found to be 0.081. The free energy of the reaction (2) RTlog $k = 0.84$ volt, and the reaction generating the current consists of two, viz., a reduction $\text{Ag} \rightarrow \text{Ag}$ and an equivalent oxidation $2\text{NO}_2 \rightarrow \text{NO}_3 + \text{NO}$. The oxidising and reducing power of nitrites in passing into nitrites and NO was found to be intermediate between the acid H_2 - and acid O_2 -electrodes.

528. *Action of Electrolytes on Colloidal Solutions.* E. F. Burton. (Phil. Mag. 12, pp. 472-478, Nov., 1906.)—The whole superstructure of the theory of the coagulation of colloids is built upon the results of Hardy's experiments on egg-albumen [Abstract No. 1529 (1900); Journ. of Physiology, vol. 29, p. 26, 1906]; as, however, it has been suggested that the behaviour of the albumen particles may be due to the fact that albumen is an amphoteric substance

capable of acting as a base towards acids and as an acid towards bases, the present conclusive experiments were made. Traces of aluminium sulphate were added to colloidal solutions of gold and silver and were found in each case to produce a change in the direction of migration of the particles in an electric field; the existence of an isoelectric point was demonstrated, and thus the treatment of the case as analogous to Hardy's egg-albumen experiment was justified. D. H. J.

529. *Ebullioscopic Behaviour of Aliphatic Acids with Anomalous Vapour Densities.* E. Beckmann. (Zeitschr. Phys. Chem. 57, pp. 129-146, Nov. 20, 1906. Communication from the Laborat. f. angewandte Chemie d. Univ., Leipzig.)—An experimental investigation by the ebullioscopic method showed that even in the case of solvents like acetic acid (which has an anomalous vapour density but a constant boiling-point) the boiling-point constant of the solvent may be calculated by the van't Hoff-Beckmann-Arrhenius formula: $K = 0.02T^2/w$. D. H. J.

530. *Relations between the Heat developed and the Maximum Work in Condensed Systems.* W. Nernst. (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 52, pp. 983-940, 1906.)—In the case of condensed systems the author's theory [see Abstract No. 1141 (1906)] shows that the heat evolved in a reaction can only be represented by $Q = Q_0 + \alpha T + \beta T^2 + \gamma T^3$ if α be zero, in which case the maximum work done is $W = Q_0 - \beta T^2 - \gamma T^3$. These formulae are applied to (1) the transformation of one optical isomer into its opposite, (2) the transformation of prismatic into octohedral sulphur, (3) the formation of crystalline hydrates, (4) the e.m.f. of a Clark cell. R. E. B.

531. *Relation of Chemical Activity to Electrolytic Conductivity.* J. L. Sammis. (Journ. Phys. Chem. 10, pp. 598-625, Nov., 1906.)—The change produced in the velocity of inversion of cane-sugar in a solution containing acid and water by replacing part of the water by benzene or acetone is quite out of proportion to the change in conductivity, and is not in all cases in the same direction. Similar results are obtained in the catalysis of methyl acetate by acids and in the solution of magnesium by acids. The replacement of one metal by another takes place in molten salts or non-conducting solutions, as well as in liquids which are good electrolytes. From these observations and those of Kahlenberg [see Abstract No. 1891 (1902)], it is concluded that the generally-accepted view that electrolytic conduction and chemical activity are proportional is of no general applicability. (Ibid. 11, p. 92, Jan., 1907, Errata.) T. H. P.

532. *Electrical Conductivity of Mixtures of Bromine and Ether.* W. Plotnikow. (Zeitschr. Phys. Chem. 57, pp. 502-506, Dec. 21, 1906. Polytechnikum Kiev, May, 1906.)—A solution of ether in bromine has a marked electrical conductivity—only slightly less than that of concentrated aqueous solutions of salts. The specific conductivity first increases rapidly with the concentration, becomes a maximum at about 11.5 per cent., and then slowly decreases; the maximum corresponds approximately to the formula $(C_2H_5)_2O \cdot Br_2$. A solution of bromine in ether shows but little conductivity; the specific conductivity of a mixture with a small percentage of ether is some hundred thousand times as great as that of a mixture with a small percentage of bromine. Between the regions of great and small conductivity lies a concentration region in which the solution separates into two layers.

The author is of opinion, that the values of the dielectric constants, the association factors, the viscosity, &c., are not sufficient to determine whether a pair of substances will form a conducting solution; the electrolytic conductivity of solutions appears to depend on a special electrochemical interrelationship between two substances. D. H. J.

533. *Spectrophotometric Study of Solutions of Copper and Cobalt.* B. E. Moore. (Phys. Rev. 23, pp. 821-857, Nov., 1906. Zeitschr. Phys. Chem. 55, pp. 641-682, June 26, 1906. Translation.)—The experimental study included the chloride, sulphate, nitrate, and acetate of copper, and the chloride, sulphate, and nitrate of cobalt [see Abstract No. 1208 (1905)]. Both concentrated and dilute solutions were examined—in presence and in absence of salts, and acids added to repress ionisation. Ostwald's law that dilute solutions containing a common coloured ion have a common colour, was confirmed. A diminished association due to added salts and acids which contain a common ion was observed, and may be interpreted as confirming the dynamic law of mass action between ions. D. H. J.

534. *Cryoscopy of Colloidal Hydrochloroferric Solutions.* G. Malfitano and L. Michel. (Comptes Rendus, 143, pp. 1141-1148, Dec. 24, 1906.)—The freezing-points of these solutions were determined both before and after filtration (to remove the colloid particles) through collodion. The differences of freezing-point thus found were very small and uncertain, so that no definite molecular weights can be ascribed to the colloidal particles. The number of ions present in the solutions must also be so small as to elude cryoscopic measurements. D. H. J.

535. *Molecular Conductivity and Ionisation in Organic and Inorganic Solvents.* Dutoit. (Zeitschr. Elektrochem. 12, pp. 642-644, Aug. 17, 1906. Paper read before the 18 Hauptversamml. der Deutsch. Bunsen-Gesell. in Dresden.)—(1) The following table shows the molecular conductivity of sodium iodide in different solvents:—

		N/500.	N/8000.	As.
Acetone.....	18°	121.0	148.8	155.5
Methylethylketone	25	89.0	120.8	129.5
Acetophenone	25	25.7	82.0	84.5
Methyl Alcohol	18	82.8	88.0	89.0
Ethyl "	18	88.5	88.0	88.8
Propyl "	18	14.7	18.7	19.0
Isobutyl "	25	7.18	11.15	12.65
Acetonitrile	18	182.5	144.5	(152)
Benzonitrile	25	87.0	48.7	47.0
Pyridine	18	87.7	52.2	58.0
KI in SO ₂	-15	98.8	158.5	202.0

(2) The Kohlrausch law of independent ionic mobilities holds good in alcohol, ketones, nitriles, pyridine, and SO₂. (3) The dissociation in any given solvent also appears to be an additive property, the order of decreasing ionisation being: Rb, K, Na, Li, NH₄ for the kathions; I, CNS, Br, Cl for the anions. For ternary electrolytes the law is more complex. (4) The dilution law varies for different electrolytes, but Ostwald's law often holds good beyond a certain dilution, e.g. for solutions in ketones, pyridine, and SO₂ beyond N/1000. (5) The theory put forward by the author with Miss Aston, that ionisation

depends on the polymerisation of the solvent, is withdrawn. (6) By measuring the conductivity of solutions at dilutions from $N/50000$ to $N/200000$ a limiting value of the molecular conductivity has in all cases been actually reached. The exceptional behaviour of organic solvents, which has suggested that the dissociation theory is not applicable to them, is confined to relatively strong solutions in which complexes, polymers, &c., may be formed.

T. M. L.

536. *Hydrolysis of Ammonium Salts by Water.* E. G. Hill. (Chem. Soc., Journ. 89, pp. 1273-1289, Aug., 1906.)—The ammonia liberated by air bubbling through an aqueous solution of an ammonium salt was determined by passing it into water and measuring the electrical conductivity of the solution. In the case of the monobasic acids it was found that the hydrolysis of the salt was inversely proportional to the square of the strength of the acid, i.e., to the square of the conductivity of the solution of the acid or its ionisation constant. The dibasic acids gave a more complex relationship.

T. M. L.

537. *Dyeing and Ionisation.* L. Vignon. (Comptes Rendus, 144, pp. 81-88, Jan. 14, 1907.)—The author has determined the molecular electrical conductivities of aqueous solutions of different dye-stuffs (picric acid, fuchsine, &c.) at different temperatures and dilutions, and has thus shown that rise of temperature and increase of dilution—factors which increase the dyeing effect—cause increased ionisation of the solutions. There thus appears to be a connection between dyeing and ionisation. Of interest in this connection is the fact that textiles of animal origin (silk, wool) take up sulphuric acid or barium hydrate from aqueous solutions, and that the relative proportion of acid or base taken up increases with the dilution of the acid or base.

D. H. J.

538. *Ionisation of Silver Nitrate Solutions.* R. Abegg. [Experiments by A. C. Cumming.] (Zeitschr. Elektrochem. 13, p. 13, Jan. 13, 1907. From the Chem. Universitätslaborat., Breslau.)—The p.d. between solutions of silver nitrate of different strengths, ranging from $N/1000$ up to $N/2$, are accurately determined, the diffusion-potential being diminished with the help of solutions of nitrate of ammonium or of potassium. The electrodes are pure silver wires or platinum wires coated with silver. The observed potentials show that in this case the conductivity of the electrolyte is a measure of its ionisation, which, according to Jahn [see Abstract No. 1888 (1900)], does not apply to strong electrolytes, while A. A. Noyes considers it as generally true. (The full paper was read by Cumming before the Faraday Soc., Dec. 11, 1906.)

H. B.

539. *Dissociation of Matter under the Influence of Light and Heat.* G. Le Bon. (Comptes Rendus, 143, pp. 647-649, Oct. 29, 1906.)—The experiments previously described by the author (*l'Evolution de la matière*) lead to the conclusion that, in the action of light on matter, two very different effects may sometimes be superposed: (1) light dissociates matter, but, (2) if its intensity is sufficient to heat the substances on which it acts, it expels a small quantity of radio-active elements contained in all substances by virtue of their spontaneous dissociation [compare Ramsay and Spencer, Abstract No. 380 (1907)]. This latter action is evidenced by the following observations: A charged electroscope surrounded by a thin metallic cylinder undergoes partial

discharge if exposed to the sun in summer, but this discharge soon stops and only begins again when the metallic cylinder is replaced by another. A similar effect is obtained in the dark if a body heated to 400–500° or gases from a flame are brought near to the charged electroscope surrounded by the metallic cylinder; in this case the discharge, which amounts to about 0.01 volt in 8 or 4 min., may be repeated several times, but the metal ultimately becomes inert, and only regains its discharging power after several weeks. T. H. P.

540. *Dissociation of Water Vapour and Carbon Dioxide at High Temperatures.* I. Langmuir. (Amer. Chem. Soc., Journ. 28, pp. 1357–1379, Oct., 1906.)—When water vapour or CO₂ is passed through a tube containing a glowing platinum wire, amounts of dissociation products are obtained corresponding with the dissociation equilibrium at the temperature of the wire. The values thus found for the degree of dissociation are—for water vapour 9.5, and for CO₂ 7 per cent. lower than those of Nernst and v. Wartenberg [Abstracts Nos. 1808 and 1809 (1906)]. Platinum and platinum-rhodium wires do not disintegrate perceptibly in steam or CO₂ up to 1,800°. The method of measuring dissociation of gases by means of a glowing wire is recommended, as the great rapidity of cooling of the gases insures accurate results. T. H. P.

541. *Endothermal and Exothermal Processes of Dissociation.* J. J. van Laar. (Zeitschr. Phys. Chem. 57, pp. 688–689, Jan. 8, 1907.)—Endothermal and exothermal reactions cannot be contrasted unless by reaction is meant dissociation from the more complex to the less. Only relatively few dissociation-processes are exothermal, and these all become ultimately endothermal as the temperature rises. This proposition is proved by showing that at very high temperatures no exothermal dissociation is possible, the simpler of two systems concerned in a dissociation-reaction being defined to be that for which $\Sigma \cdot v$ or $\Sigma \cdot v k$ or both are the greater, where k denotes molecular specific heat at infinite volume and v the number of molecules concerned in the reaction. The calculation is illustrated by two examples, and is shown to be in accordance with a result given by Willard Gibbs. R. E. B.

542. *Catalysis and Electromotive Force.* 1. A. Brighenti. (Gazzetta Chim. Ital. 36. 1, pp. 187–215, 1906.)—Platinum black, prepared by the method given by Loew (Ber. Deut. Chem. Gesell. 23, p. 289, 1890), exerts a much greater catalytic action than platinum obtained by reduction with zinc. Palladium behaves similarly to platinum, and a certain catalytic activity is also exhibited by silver and by the oxides of Ni, Fe, Co, and Mn. Of the solvents used, water is the one exercising the greatest retarding action on the catalysis, probably owing to its hydrolysing effect on the alkoxides. On immersing a large electrode of platinised platinum and a small one of smooth platinum in an alcoholic solution of the corresponding sodium alkoxide, an e.m.f. is observed, which is not, however, very constant, and varies with the time at which the circuit is closed and with the surface of the electrodes; the measurement of the polarisation is hence rendered difficult, the voltage-intensity curves being somewhat irregular. The effect of platinum black on the reduction potential of methyl alcohol is also produced by formaldehyde, and as the latter can be formed by the catalytic action of the platinum on the alcohol, it is to the production of aldehyde that the author attributes the action of the platinum. The results are discussed theoretically. T. H. P.

543. Elimination of the Contact Potentials of Liquids. **R. Abegg.** [Experiments by **A. C. Cumming.**] (*Zeitschr. Elektrochem.* 13. pp. 17-18, Jan. 18, 1907. From the chem. Universitätslaborat., Breslau.)—The potentials due to the contact of two liquids can be calculated after Nernst and Planck if the concentration and mobility of the ions are known. Bjerrum reduces this diffusion-potential by interposing a concentrated solution of KCl between the two liquids, e.g., normal and diluted hydrochloric acid in couples of $\text{Hg}/\text{Hg}_2\text{Cl}_2$. The author finds by experimenting with solutions of KNO_3 , NH_4NO_3 , NaNO_3 , LiCl as intermediate liquid, that the solution should be concentrated and its positive and negative ions should have the same mobility. Ammonium nitrate answers best. When two cells containing the same solution (HCl or LiCl in the couple mentioned above) are joined by a third solution of the same electrolyte, the potential of the cell does not change, and is independent of the concentration of the third solution. This follows from Nernst's theory, but had not so far been observed. (The full paper was read by Cumming before the Faraday Soc., Dec. 11, 1906.) **H. B.**

544. Transfer Number of Concentrated Caustic Potash. **G. Nordström.** (*Zeitschr. Elektrochem.* 13. pp. 85-87, Feb. 1, 1907. Communication from the Inst. f. phys. Chemie, Göttingen.)—Two U-tubes of glass are filled with caustic potash and connected by a horizontal branch containing a stop-cock; the anode is of platinum, the kathode of nickel. The apparatus is kept at 18° in a thermostat. The resulting mean transfer number for KOH is 0.224; the value decreases with rising concentration from 0.230 (KOH of 5 per cent.) to 0.217 (KOH of 80 per cent.). In an alkali accumulator [compare Zedner, Abstract No. 1490 (1906)], both the potash and the water would be moved, and a fall of potential of the nickel oxide electrode, due to the increased potash concentration, by 0.04 volt would, with a discharge at 0.8 amp., become noticeable within $\frac{1}{2}$ amp.-hour. **H. B.**

545. Measuring Unsteady Potentials with the Aid of the Iodine Potential. **L. Loimaranta.** (*Zeitschr. Elektrochem.* 13. pp. 83-84, Feb. 1, 1907. From the chem. Universitätslaborat., Breslau.)—The oxidation potential $\text{As}^{\text{III}} \rightarrow \text{As}^{\text{V}}$ remains ill-defined for weeks, but becomes at once steady if iodine or iodide is added to the solution, as Maitland did in determining the equilibrium ferro-ferri-iodine-iodine ion [see Abstract No. 1145 (1906)]. The solution of arsenious and arsenic acids must contain sulphuric acid and a little, but not too little, iodide of potassium. A well-defined simultaneous potential is a sign of equilibrium. In the same way the oxidation potentials $\text{Cr}^{\text{VI}} \rightarrow \text{Cr}^{\text{III}}$ and thiosulphate $\rightarrow$ tetrathionate can be determined. **H. B.**

546. The Hydrogen-Oxygen Cell. **F. Haber and G. W. A. Foster.** Parts II. and III. (*Zeitschr. Anorg. Chem.* 51. 8. pp. 289-314, Dec. 8, 1906. Chem.-techn. Laborat. der techn. Hochschule, Karlsruhe.)—The authors have carried out measurements of the e.m.f. of concentration cells formed of hydrogen, oxygen, and detonating gas, and find that at 850° , with Pt and Au electrodes, and with porcelain as electrolyte, the e.m.f. agrees satisfactorily with that calculated from the thermodynamic theory. The same was found also with Pt electrodes at $1,000^\circ$. In the case of detonating-gas cells, it is necessary to have the same concentration of water vapour in the two gases. The theory of these cells was worked out on the assumption that the porcelain is not indifferent to water vapour, and the results were in fairly good agree-

ment with this. [See also Abstract No. 986 (1906).] **F. Haber.** (Ibid. pp. 858-868.)—III. The author communicates some of the results obtained by W. H. Patterson, working under his direction, in an investigation of the e.m.f. of the Grove cell $\text{Pt}_{100} | \text{Fused caustic alkali} | \text{Fe}_{100}$. The chief conclusions drawn from the measurements are: The positive Pt electrode of the Grove cell is an oxygen electrode of the second kind. The phenomena of formation and decomposition of water at the ordinary temperature, exhibit peculiarities because the reaction $\text{O}_2 + 2\text{H}_2\text{O} + 4\text{e}^- \rightleftharpoons 4\text{OH}^-$ takes place in two stages, the occurrence of which is sometimes accompanied by a retardation of change. The surface of the platinum is altered chemically by strong oxidising agents and by anodic polarisation. The solid platinum compound formed liberates iodine from an acid starch-iodide solution. [See also Abstract No. 171 (1907).] **A. F.**

547. Electrolytic Preparation of Ozone. Parts I. and II. **F. Fischer and K. Massenez.** (Zeitschr. Anorg. Chem. 52. 2. pp. 202-218, Jan. 28, 1907. I Chem. Inst. d. Univ., Berlin, June, 1906.)—Reviewing the literature on the subject, the authors point out that the necessity of cooling the electrolyte had been recognised, but not the necessity of cooling the electrodes. Their glass cells consist of an anode compartment, bell-shaped, between two kathode compartments, the horizontal connections being stuffed with glass wool. The electrolyte is sulphuric acid of density 1.075 to 1.1. An acid of density 1.8 polishes the platinum anode, while the ozone percentage is diminished; anodes thus polished gave, however, better yields in the less concentrated acids. The anode is a fine platinum tube, 1.1 and 1.5 mm. internal and external diam. respectively, inserted between two glass tubes, so that water can be forced through the anode. Most of the platinum is embedded in glass, only a small portion being left bare. The best yield, an oxygen containing 17 per cent. of ozone, was obtained when the platinum was entirely fused into glass and filed off afterwards so as to expose a fine line of metal. From this electrode, which lasts several months, the gas-bubbles rise freely. Continuous currents of 110 volts and 58 amps./cm.² at 5° C. are recommended. McLeod had also obtained a 17 per cent. ozone, but his platinum wires were quickly destroyed. (Ibid. 52. 3. pp. 229-255, Feb. 5, 1907.)—In their continued experiments the authors find a sharp-cornered platinum tube, of rhombic section, embedded in glass all except a horizontal edge 11.5 mm. in length, 0.1 mm. in width, gives the best yields. Of the many electrolytes tried, phosphoric, nitric, chromic, hydrofluoric acids, caustic alkalis, sulphates, &c., sulphuric acid answers best; the acid density should be less than 1.228; for high-density currents the acid must be more diluted. Only platinum electrodes are suitable, lead peroxide is destroyed. The ozone percentage rises at 18° C. to 28, and at -14° C. (cooling with calcium chloride) to 28 per cent.; the best energy yield was 7.18 gm. of ozone (of 21.4 per cent.) per kw.-hour, at 7.8 volts, cooling with water from the mains. As the ozone potential (against the hydrogen electrode) is -1.69 volts, and that of the hydroxyl ions, which are characteristic for the oxygen liberation, -1.68 volts, the authors suggest that the oxygen is really liberated as ozone of 100 per cent., but is rapidly decomposed by contact with the platinum and by heat. That the ozone is formed by the decomposition of persulphuric acid does not appear probable. **H. B.**

548. Electrolysis through Precipitation Films. I. **W. S. Millar and W. W. Taylor.** (Roy. Soc. Edinburgh, Proc. 26. pp. 447-468, 1905-1906.)—It has been recognised by Hittorf that diaphragms affect different ions to

a different extent, and in their investigations of the aluminium anode Inglis and Taylor had observed that precipitation films of aluminium hydroxide seemed to have such an effect. In the present experiments, the authors support their films on a diaphragm of porous earthenware, various styles of filter paper having proved unsuitable. Both compartments of the cell are first filled with a solution of ammonium chloride, for instance; the resistance of the cell having been ascertained by the bridge and telephone method (alternating currents), the one compartment is charged with the same chloride and a little Al_2Cl_3 , the other with NH_4Cl and a little ammonia; almost the whole of the conductivity will then be due to the ammonium chloride, and no third salt solution will be formed and absorbed by the film, from which it would be very difficult to remove it again. Most of the experiments were made at $25^\circ C$. It results that the initial resistance values of cell plus diaphragm are less concordant than the final increased resistances of the cell plus diaphragm and film. In the series NH_4Cl , NH_4Br , $(NH_4)_2SO_4$, the film of aluminium hydroxide reduced the conductivity of the chloride by 8, of the bromide by 7, and of the sulphate by 20 per cent.; the kation being common, these diminished conductivities are due to the anions Cl^- , Br^- , SO_4^{2-} . In the series, sulphates of NH_4 , K , Na , with a film of chromic hydroxide, K^+ and NH_4^+ are affected to about the same extent, less than Na^+ . For the two kinds of films, aluminium and chromic hydroxide, the order of the effects on the ions is the same, but there is no proportionality. Suitable ferric hydroxide films could not be prepared. In most cases the results may be grouped as high or low; the colloidal films seem to exist in two modifications which pass into one another. The temperature-coefficient of a cell containing a chromic hydroxide film and ammonium sulphate is much greater than Kohlrausch's temperature-coefficient of the sulphate. When a direct current is sent for a time through the cell such as would strengthen the aluminium hydroxide film, the conductivity is temporarily reduced. The resolution by this method of racemic compounds into their optically-active components has not so far succeeded.

H. B.

549. Alternating Current Electrolysis with Cadmium Electrodes. G. R. White. (Amer. Electrochem. Soc., Trans. 9, pp. 805-812; Discussion, pp. 812-814, 1906.)—The author shows that, in the preparation of cadmium sulphide by the electrolysis of sodium thiosulphate with cadmium electrodes, the efficiencies given by le Blanc and Schick [Abstract No. 1288 (1904)] for currents of rapid alternation can be greatly increased. The efficiencies are, however, too low for a commercial process, and the sulphide is apt to be contaminated with oxide. The efficiency is practically independent of the current strength, of the temperature and of stirring, and depends almost entirely on the electrode surface.

T. H. P.

550. Electrolytic Precipitation of Bronzes. B. E. Curry. (Journ. Phys. Chem. 10, pp. 515-520, Oct., 1906. Amer. Electrochem. Soc., Trans. 9, pp. 249-253; Discussion, p. 254, 1906.)—Good bronzes may be deposited electrolytically from solutions containing oxalic acid, ammonium oxalate, copper sulphate, and stannous oxalate. The proportions of copper and tin in the bronze obtained differ widely from those in the electrolysed solution, a bronze containing 77 of Cu to 23 of Sn being yielded by a liquid in which the Cu and Sn are in the ratio of 20:80; it is, indeed, difficult to precipitate a good bronze containing less than 75 per cent. of Cu. A rotating cathode should be used and the cathode current-density should be low, good results

being obtained by 0.2 to 2.0 amps. per sq. dm. The electrolytic bronzes correspond closely in colour and appearance with cast bronzes of similar compositions.

551. Electrolytic Chromium. M. Le Blanc. (Amer. Electrochem. Soc., Trans. 9, pp. 815-827; Discussion, pp. 827-831, 1906.)—Electrolytic chromium can be obtained in smooth, thin, adherent deposits, but the formation of thicker layers and the production of coherent masses of electrolytic chromium are, however, so far prevented by the brittleness of the metal, and its tendency, when in thick layers, to develop fissures and cracks. The conditions of working are discussed. [Compare Abstracts Nos. 1149 and 1510 (1905).]

T. H. P.

552. Electrolytic Precipitation of Gold, using a Rotating Anode. J. R. Withrow. (Amer. Chem. Soc., Journ. 28, pp. 1350-1357, Oct., 1906. Contribution from the John Harrison Lab. of Chemistry, No. 100.)—The precipitation of gold electrolytically is found to proceed better in presence of potassium cyanide than in sodium sulphide. Using 0.2754 gm. of gold in the form of chloride in 80 c.cm. of solution containing 2.5 gm. of potassium cyanide, a current of 5 amps. at 8-7 volts deposits all the gold in 8 min. With a mercury cathode making 300-500 r.p.m. and a silver-plated dish as anode, the constituents of potassium chloride or iodide can be readily determined, the halogen giving a firm, adherent deposit in either case.

T. H. P.

553. Simple Form of Rotating Electrode for Analysis. F. M. Perkin. (Faraday Soc., Trans. 2, pp. 91-98, Dec., 1906. Chem. News, 93, p. 283, June 22, 1906. Electrician, 57, pp. 386-387, June 15, 1906.)—The cell described consists of a tap funnel in the centre of which is suspended a spiral cathode of iridio-platinum wire containing 20 per cent. Ir, and having a total active surface of about 23 sq. cm. Two or three spirals of 1-mm. Pt wire, fitting tightly against the side of the funnel, serve as anode. Cathodes of Ni may be satisfactorily employed for the deposition of many metals, e.g., Cu, Zn, and Fe. Even platinum is attacked by a 4 per cent. solution of potassium cyanide when subjected to high current-densities, 0.0016 gm. being dissolved from a surface of 10 sq. cm. by a current of 8 amps. passed for 50 min.

W. H. St.

554. Electrochemical Analysis of Alloys Rich in Chromium. G. Gallo. (Accad. Lincei, Atti, 18, pp. 58-67, Jan. 6, 1907.)—Ferrochromes and other alloys of iron containing a high proportion of chromium are readily dissolved prior to analysis, by electrolysis of a 15 per cent. solution of KCl, rendered slightly alkaline with potassium hydroxide, using the alloy under examination as anode and a platinum wire cathode. With a current of 0.5 amp. at a p.d. of 8-10 volts, 1 gm. of metal is dissolved in 4 hours, the Cr being oxidised to chromate, which remains in solution, while the iron, and any Ni and Mn, are precipitated as hydrates.

W. H. St.

555. Electrolysis of Aqueous, Acetone, and Pyridine Solutions of Thiocyanates. S. Binning and F. M. Perkin. (Faraday Soc., Trans. 2, pp. 94-97, Dec., 1906.)—Electrolysis of a slightly acid solution of ammonium thiocyanate yields a yellow-coloured product resembling canarine. With ordinary electrodes the anode soon becomes coated with the colouring

matter, and the resistance thereby seriously reduced; but by using a cylindrical Pt anode, within which rotates a cathode, consisting of a lead fan through the vanes of which bristles are passed, to continually brush the anode, and employing a current of 5 amps., the p.d. between the electrodes being 5 volts, a yield of from 15 to 20 per cent. of the yellow substance is obtained. In alkaline solution no coloured body is formed. Electrolysis of 20 per cent. solutions of ammonium thiocyanate in dry acetone and in pyridine, using the same apparatus, also gives yellow precipitates, in the former case directly, and in the latter on dilution with water, but neither of these precipitates has the properties of canarine. W. H. St.

556. *Migration of Ions in Electrolysis of a Molten Mixture of Two Salts.* R. Lorenz and W. Ruckstuhl. (Zeitschr. Anorg. Chem. 52. 1. pp. 41-47, Jan. 3, 1907. Laborat. f. physik. Chemie u. Elektrochemie, am eidg. Polytechn., Zürich, Oct., 1906.)—The authors have electrolysed molten mixtures of lead and potassium chlorides, and measured the migration velocities of the ions. The numbers obtained for the lead ion point to the conclusion that complex compounds of the two chlorides exist in the melt. The most stable complexes exist in the presence of excess of potassium chloride, since an excess of this salt suppresses the dissociation of the lead chloride, and therefore favours the production of complex ions. [See Abstract No. 486 (1905).] T. S. P.

557. *Electrochemistry of Lead.* R. Abegg. [Research by A. C. Cumming.] (Zeitschr. Elektrochem. 13. pp. 19-21, Jan. 18, 1907. From the Chem. Universitätslaborat., Breslau.)—Plumbi-ions can exist only in very small concentrations in aqueous solutions, as they tend to pass from the Pb^{++} ion into the plumbo Pb^{+} ion under oxidation of other substances. Pure simple plumbic salts are very unstable. The author dissolves the plumbic PbO , in nitric acid (determining the slight solubility which increases with higher concentration of the acid), and measures the oxidation potential of lead peroxide electrodes against a normal calomel electrode, saturated ammonium nitrate solution serving as connection. The mean value of the tendency of plumbi-ion to pass into plumbo-ion seems to be +1.82 volts (against the hydrogen standard electrode), the tendency for the change $Pb^{++} \rightarrow Pb$ to be -0.187 volt, so that the value for $Pb^{++} \rightarrow Pb$ (metal) is +0.84 volt. In approximately determining the concentration of plumbion in nitric acid, platinum points plated with lead from lead acetate are used: in alkaline nitrates this concentration varies greatly; there is a complex $KNO_3 \cdot Pb(NO_3)_2$, but no corresponding complex with $NaNO_3$. Similar experiments were also made with solutions of PbO in caustic soda. (The full paper was read by Cumming before the Faraday Soc., Dec. 11, 1906.) H. B.

558. *Electrolytic Formation of Copper Peroxide.* E. Müller and F. Spitzer. (Zeitschr. Elektrochem. 13. pp. 25-27, Jan. 25, 1907. From the Inst. f. Elektrochemie u. techn. Chemie d. techn. Hochschule, Stuttgart.)—When an ammoniacal solution of copper oxide is electrolysed, some peroxide seems to be formed and reduced again by the ammonia. The authors electrolyse an anode of copper in 12N caustic soda; the anode becomes coated with an orange-coloured film, and the blue liquid turns green and turbid with yellow particles, while oxygen is liberated. The experiment succeeds best when a U-tube of lead, coated with copper and cooled, is used

as anode. Grouping two caustic-soda voltmeters in series, the one containing a platinum anode, the other a copper anode, the authors conclude, from the excess of oxygen collected in the second voltmeter, that the orange-coloured oxide is Cu_2O . The higher copper oxides have little been studied. H. B.

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550. *Principles of Resistor Furnace Design.* C. L. Collens. (Amer. Electrochem. Soc., Trans. 9, pp. 81-92; Discussion, pp. 93-96, 1906.)—A theoretical paper, unsuitable for abstracting. T. H. P.
551. *Radium and the Properties of its Combinations.* H. Wilde. (Manchester Lit. and Phil. Soc., Mem. 51, 2, pp. 1-13, Jan. 18, 1907. Chem. News, 94, p. 285, Dec. 14, 1906.)—The paper is largely historical. From a consideration of the periodicity of the elements the author maintains that the determinations of Curie, Runge, and Precht afford no reason for changing the position of radium in the table of the elements—this position being next above barium in the alkaline-earth group, with an atomic weight of 184 (not 226 as assigned by Curie) and a proximate specific gravity of 5. D. H. J.
552. *Kinetics of Photo-chemical Reactions. 1. Retarding Effect of Oxygen on Photo-chemical Reactions of Chlorine.* R. Luther and E. Goldberg. (Zeitschr. Phys. Chem. 56, pp. 43-58, July 17, 1906. Dissertation; extract from Zeitschr. Wiss. Phot. 4, p. 61, 1906.)—The retarding effect of oxygen on the photo-chlorination of hydrogen and CO also appears in the photo-chlorination of benzene, toluene, xylene, and acetic acid. T. H. P.
553. *Equilibrium in the Deacon Chlorine Process.* G. N. Lewis. (Amer. Chem. Soc., Journ. 28, pp. 1380-1395, Oct., 1906. Contribution from the Research Lab. of Phys. Chem., Mass. Inst. of Technology, No. 18.)—Results are given of the determination of the equilibrium in the reaction $4\text{HCl} + \text{O}_2 \rightleftharpoons 2\text{H}_2\text{O} + 2\text{Cl}_2$, in presence of cupric chloride as catalyst and at various temperatures. At constant temperature the results are in accordance with the mass law. An equation is given from which the equilibrium constant at any temperature may be calculated. The most probable value of the e.m.f. of the hydrogen-oxygen cell is 1.212 volts at 25°. T. H. P.
554. *Conductivity of Mixtures of Electrolytes.* III. F. Barmwater. (Zeitschr. Phys. Chem. 56, pp. 225-235, July 17, 1906. Polytechnikum, Kopenhagen, April, 1906.)—[See also Abstract No. 620 (1904).] D. H. J.
555. *Determination of the Electrical Conductivity of the Iodide, Bromide, and Chloride of Potassium in Ethyl and in Methyl Alcohol.* D. Stenquist. (Zeitschr. Elektrochem. 12, pp. 860-862, Nov. 23, 1906.)—The measurements were made at 0° C., and at temperatures in the neighbourhood of 18°, by the Wheatstone bridge and telephone method; the results are presented in the form of six tables. [Compare Abstract No. 1451 (1904).] D. H. J.
556. *Hydrolysis of Ammonium Salts in Presence of Iodides and Iodates.* S. E. Moody. (Amer. Journ. Ser. 22, pp. 379-383, Nov., 1906. Contribution from the Kent Chem. Lab. of Yale Univ.) D. H. J.
557. *Viscosity of Supercooled Solutions in Thymol.* C. Schall. (Phys. Zeitschr. 7, pp. 645-648, Sept. 15, 1906. Phys. chem. Inst. Leipzig.)—This paper is partly a supplement to the previous one [Abstract No. 494 (1903)]; partly a summary of available data. D. H. J.

567. Polymerisation of Liquids. P. Bogdan. (Zeitschr. Phys. Chem. 57. pp. 849-856, Dec. 11, 1906.)—The author gives a general discussion of the molecular condition of liquids, and endeavours to co-ordinate the different formulae (of van't Hoff, &c.) and practical rules (of Ramsay, Young, Eötvös, &c.). He concludes that liquids are more or less polymerised and that the formation of complexes takes place even at the critical temperature. The known empirical rules do not give us the absolute, but only the relative molecular weights of liquid substances. D. H. J.

568. Oceanic Salt Deposits. XLIII. J. H. van't Hoff [with W. C. Blasdale]. (Preuss. Akad. Wiss. Berlin, Sitz. Ber. 34. pp. 712-714, 1905.) XLIV. With J. d'Ans. (Ibid. 44. pp. 913-916, 1905.) XLV. With W. C. Blasdale. (Ibid. 52. pp. 1086-1090, 1905.) XLVI. With P. Farup and J. d'Ans. (Ibid. 6. pp. 218-224, 1906.) XLVII. With J. d'Ans. (Ibid. 22. pp. 412-419, 1906.) XLVIII. (Ibid. 34. pp. 566-574, 1906.) [A summary of van't Hoff's first 30 papers dealing with these deposits is given in Zeitschr. Anorg. Chem. 47. 2. pp. 244-280, 1905.]

569. Abnormal Depression of Transition Temperature in Mixed Crystals. H. E. Boeke. (Zeitschr. Phys. Chem. 56. pp. 686-688, Sept. 28, 1906.)—Small proportions of sodium sulphate cause an abnormally great depression of the transition temperature of γ - into δ -sodium molybdate. No explanation of this phenomenon is advanced.

T. H. P.

570. Ion-formation of Sulphur. Complex Ions of Mercury. J. Knox. (Zeitschr. Elektrochem. 12. pp. 477-481, July 18, 1906.) From the Chem. Universitätslaborat. Breslau.)—A method is given by which the content of S^{2-} , HS^{-} , H^{+} and OH^{-} ions, in any aqueous sulphide solution may be found. T. H. P.

571. Equilibrium and Transformation of the Isomeric Chromium Chloride Hydrates. J. Olie, Jr. (Zeitschr. Anorg. Chem. 51. 1. pp. 29-70, Oct. 18, 1906. Anorg. Chem. Laborat., Amsterdam, Aug. 14, 1906.)

572. Hydration in Solution. C. S. Hudson. (Phys. Rev. 23. pp. 370-381, Nov., 1906.)—Deals with the thermodynamics of hydration reactions and the solubility of hydrate-forming substances.

573. Processes Operative in Solutions. I. Sucroclastic Action of Acids as Influenced by Salts and Non-electrolytes. R. J. Caldwell. (Roy. Soc., Proc. Ser. A. 78. pp. 272-295, Nov. 5, 1906.)—Experiments were made to determine the influence on the hydrolysis of cane-sugar by acids, of lactose, glucose, glycerol, alcohol, acetic acid, and the chlorides of potassium, ammonium, barium, calcium, and sodium. The solutions were made up in such a way that the relative weights of sugar, water, and acid were kept constant. T. M. L.

574. Ionisation of Fused Salts. H. M. Goodwin and H. A. Wentworth. (Phys. Rev. 24. pp. 77-92, Jan., 1907. Contribution from the Research Lab. of Phys. Chemistry, No. XII.)—The authors have determined the e.m.f. of silver nitrate and chlorate concentration cells in the fused state, and conclude that Nernst's theory of the cell and the laws underlying the mutual effect of one ionised salt on another hold for salts in the molten state as well as in aqueous solution. A. F.

575. The Carbon Cell. W. H. Patterson. (Phil. Mag. 13. pp. 181-186, Jan., 1907.)—The author has carried out some experiments which go to confirm the Haber-Bruner interpretation of the carbon cell as being really a hydrogen-oxygen cell [Abstract No. 986 (1906)]. Molten alkali was used as electrolyte and the e.m.f. of the oxygen-hydrogen cell at different temperatures measured, electrically-coated iron wire being used as hydrogen electrode, and platinum as oxygen electrode. A. F.